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ENGINEERS AT THE TOP

RECENT investigations in the United States have shown that there has of late been an increase in the number of highly qualified engineers moving from professional and research work into senior positions in companies. In some cases they have become vice-presidents and even presidents of companies of some size; in other cases they have themselves launched out to develop the commercial potentialities of some product or technical process with which they have been previously associated in the laboratory or to follow up some other possibility that they have recognised.

It might be expected that a trend of this kind would be perceptible under present conditions. The development of technology in industry has reached a stage where the engineer (and for that matter the physicist and chemist as well) has a particularly vital contribution to make in formulating policy, in producing and marketing certain products. This change has arisen for two reasons. Primarily it is because production techniques and systems of control are becoming increasingly complex. A familiar and current example of this development is the application of the more complex kinds of remote control to production lines. The second reason arises from the fact that there are a number of intricate production techniques required to-day to produce small quantities of vital equipment.

One of the interesting points arising out of an examination of the trend in the United States is the difference of opinion which exists on the desirability or otherwise of this development. Opinion is divided as to whether the scientific worker ceases to be such when he moves into commercial work, assuming the role of a business executive with mainly administrative functions, or whether there is here a definite move to get technical personnel to work at board level with the pre-conceived idea of making them exercise mainly technical influence.

Engineers have been the salt of the earth ever since the Industrial Revolution, making it more palatable to mankind, though too often leaving the business aspect to others who have no engineering experience but who make up for their lack by a shrewd insight which is not biased by specialist knowledge. The result has been that many companies have tended to be based on a philosophy of commercial opportunism. That approach has worked very well in many cases, and doubtless it will continue to do so in the future. But there is now increasing scope for the company which is based on technical opportunism. In the decade since the war this trend has been increasingly apparent. Success has come to firms which, in their organisation and in the personalities of their directors and senior executives, have been geared to the changing pattern of engineering.

This ability to observe the changing pattern and to interpret its meaning to a firm is not a quality which comes naturally to most engineers. Nor is it a quality which is consciously fostered by education. It is more likely to be acquired quite accidentally, as a result of the environment in which the young engineer finds himself or as a result of advice and training received from a more experienced engineer. The earlier it is acquired the better, not only because the young engineer will have more years in which to exercise his new-found ability but also because the knowledge he gained at college and in the works will not then become rusty; it will be kept fresh and usable even though it is not retained in all the detail that was required for examination purposes. It will serve, for example, as the essential background to a broad understanding of the kaleidoscopic changes throughout the world in the production and use of fuel and power. The first part of a special analysis of the papers and discussions at the recent World Power Conference is published in this issue of ENGINEERING. It is representative of the changes which, if correctly interpreted, can provide the basic data for future company policy. If he can do that, the engineer then qualifies for a seat on the board.

The recent history of accountancy may afford a useful parallel. Accountants are found in large and increasing numbers on company boards. In the main, they are there because company accountancy, especially the taxation side of it, is exceedingly complex and important to the business and also because accountants are very often connected with sources of finance and can help in the grouping of companies—a fashionable device in these days. Many accountants stay to perform general functions as directors and also as senior managers. It is apparent that they arrive because of their professional qualifications. They stay because current conditions require their special knowledge and their general experience. Surely a similar set of circumstances now faces the engineer? It is likely that industrial developments in the next few years will facilitate his elevation to the top positions in companies. If his general experience and ability to take a broad view are proven, he will stay. If he takes a narrow technical view, he will not. In addition, there will always be scope for the brilliant engineer who can carve a commercial niche for himself, enjoying the advantages of being his own master but running the risk of the mental loneliness which can afflict men at the top.

XUM

Plain Words

The word *jerrican*, coined in Egypt during the earlier desert campaigns, had a rather sour significance for the soldiers on the eastern side of the battlefields. It was the Germans who designed and manufactured these extremely effective sheet-metal containers for petroleum products; it was the British soldier who, with wry sense of humour, created the word which served as a tribute to the success of the cans. Our own containers were much less successful. In military terms, they were hardly more than 60 per cent. successful—that is to say, of the total volume of liquid fuel leaving bases in the Delta, about two-thirds found its way into the carburettors on trucks and fighting vehicles. The rest had disappeared either through leaks in the flimsy four gallon tins, or by splashing when the fuel was poured into the tortuous filling passages of the vehicle fuel tanks.

It would hardly have mollified the transport officers to have told them that these four gallon tins, known locally as *safias*, were never intended for the harsh service they received. At the best, they were only regarded as expendable. Indeed, their utility after their contents had been poured out was easily to be seen. Flattened out, or filled with earth or sand, the tins were used for building crude huts or dwelling-places; hence the term *bidonville*—the equivalent of shantytown further west. Indeed, for civilian purposes before the war, in the conditions then prevailing in the Middle East, the standardised four gallon tin was eminently serviceable. In the factories where they were made, stringent tests were imposed. A tin filled with water, and sealed, was dropped freely, from the height of a man's head, on to a 6 in. square timber on the floor. It had to withstand the impact without leakage.

There is a particular point in recalling these episodes just now, for there are signs in our own country of a corresponding lapse in the technique of transporting liquid fuels. But this time the lapse is in the domestic field. To an engineer, it can be revealed in terms of a sequence such as this: in the desert areas of Iraq or Arabia, oil technologists have devoted immense efforts to locating and bringing to the surface large volumes of oil. Mechanical engineers have provided magnificent pumping plant for forcing the oil across the desert. Later on, that triumph of marine architecture, a 30,000 ton tanker loaded with the oil, lifts its bows to the Atlantic swell as it emerges from the Strait of Gibraltar. Finally the oil is discharged in England at a glittering new refinery on which perhaps £20 million has been spent.

But what are the conditions in which the householder first sets eye upon the liquid that has received so continuous and such skilful attention ? Wanting a few gallons of paraffin for his oil heater, he goes to the local ironmonger where he may see a squalid array of tins that customers have brought for their paraffin. Even if he buys a new tin it will probably begin to leak within a few weeks, or the handle will come off. Having reached home, filled and lighted his heater, and done his best to wash the smell of paraffin from his hands, he then turns on the radio and listens to Sir Harold Hartley pointing out that by 1975 nuclear energy will provide only 8 per cent. of Europe's energy needs.

Here is material for moralising in plenty. The householder might reflect that if publicists had paid less attention to deluding him with fairy-tales about the atomic age, and had investigated instead continual complaints about poor workmanship, his tiresome chores might have been made less irksome. Some may remember, too, the two-gallon cans that brought petrol to open touring cars 30 years ago; and they may therefore be consoled by reflecting that if these tins, solid though they were, eventually gave way to filling-stations by the roadside, there may be a chance that an intermediate stage in the solution of the present problem may be jerricans for the home.

THE WORLD QUESTIONS ITS USE OF FUEL AND POWER

In every industrial country of the world, the use of fuel and power is being critically examined. Natural sources of energy that have taken millions of years to form are being consumed at an ever increasing pace. The relative costs of different fuels are constantly changing as old sources are worked out and new ones are exploited. As industry, expanding throughout the world, demands more and more power, so more labour and capital have to be devoted to it. There is therefore a double reason for this critical attitude to fuel and power. The World Power Conference held in Vienna last month took the theme "World Energy Resources in the Light of Recent Technical and Economic Developments." An analysis of the papers and discussions, designed to present readers of ENGINEERING *with a meaningful interpretation, has been specially prepared and the first three sections are given below.*

FINDING EFFICIENT ROLES FOR THE GAS TURBINE

World-wide interest in gas turbines was evident at the conference. Ten years ago such interest would have been attributed to the exciting industrial possibilities of gas turbines following their rapid development for aircraft during the war. To-day, a more realistic view is taken, but the industrial gas turbine cannot be ignored. A great amount of study and development work has been put into it. The experience which has been accumulated has been sufficiently encouraging to lead engineers from all the principal industrial parts of the world—Britain, Europe, U.S.A. and U.S.S.R.—to report their experiences to the conference and to project their minds towards future developments.

Aircraft gas turbines have long since come to stay (the outstanding paper on this subject was a review by Dr. A. W. Morley, of D. Napier and Son, Limited). Gas turbines running on by-products such as blast-furnace gas received some attention; and so, too, did straight gas-turbines coupled to generators for peak-load or other occasional use. The aspect on which everyone concerned had something to say was the combined steam-turbine and gas-turbine plant for electricity generation. There are various possible cycles, some of which are being put to practical test.

The advantages of the combined cycles are that exceptionally high efficiencies are possible and that the specific output (ratio of output to area of ground occupied) is higher than for a conventional steam plant. The principal cycles are: (1) gas-turbine exhaust is used for auxiliary feed-water heating; (2) gas-turbine exhaust is used to heat the combustion air for the boiler; (3) gas-turbine compressor supplies air under pressure for combustion in the boiler, the total products of combustion from the boiler pass through the gas turbine and the exhaust from the gas turbine is used in an air preheater and feed-water heater.

Two joint authors from the American General Electric Company believe that "the gains possible by the use of the combined gas-steam supercharged cycle are of somewhat greater magnitude than those previously made by the use of reheat in the straight steam cycle and can be superimposed on them and offer the greatest opportunity for improvement in efficiency of any cycle apparent on the horizon to-day."

Brown Boveri experience in this field, using a "supercharged" boiler, suggests that an overall efficiency of 37·5 per cent. can be attained with a 30 MW steam turbo-generator (efficiency 33 per cent.) allied to a 3 MW gas turbo-generator (efficiency 80 per cent.). A 230 MW plant with two 15 MW gas turbines is being designed and an overall efficiency of more than 42 per cent. is expected. Advantages claimed for these installations are:

(1) Considerable reduction in weight and size of the steam generator and of the installation as a whole.

(2) Elimination of forced and induced draught fans.

(3) Considerably quicker starting than for normal steam generators.

(4) Higher overall efficiency of the power station.

(5) Possible commercial exploitation of the condensing heat of the moisture contained in the flue gas when natural gas is burned.

(6) Simplified "erection and assembly."

Apart from their use in combined cycles, gas turbines are making slow but steady progress as straight industrial or public-service units. They are quick to start up and shut down, are independent of cooling water, and give a high degree of effective heat utilisation even in small units. At present the upper limit of capacity is about 30 MW.

Much work is being done on the use of various fuels in gas turbines. In a general report on the development of national power economies from 1950 to 1954 it is stated that the mass production of turbine engines for motor-cars is expected to place a heavy load on oil-refining capacity in the future. No difficulty is anticipated in the development of processes for providing sufficient fuel for aviation jet engines. For industrial gas turbines, oil fuel must have the least possible ash content so as to protect heat exchangers and turbine blades.

Gas-turbine power stations which supply heat as well as electricity were mentioned several times. Long-distance or district heating schemes are being tried in Germany (a closed-cycle hot-air unit) and in Paris (a 10 MW unit). A Russian paper referred to only one gas turbine under construction—an experimental 6 MW plant for utilising blast-furnace gas—otherwise the report stated that "design and research work is going on."

The Soviet Deputy Minister of the Heavy Machine Building Industry described in the discussion a number of plants, including one with a capacity of 12 MW at a gas temperature of 1,200 deg. F. Fuel used is gas of low calorific value, prepared by underground coal gasification, or heavy oil. It is reported that the turbine is a two-shaft unit, with the gas compressed to 13 atmospheres absolute pressure. With a heat-exchanger efficiency of 80 per cent., the thermal efficiency is expected to be 27 per cent. Russian experiments into the combustion of solid fuels are "not yet advanced far enough to permit industrial exploitation."

India is interested in British studies of the coal-burning external-combustion gas-turbine locomotive because it might permit the use of Indian coals. But the effect on efficiency of working under ambient Indian temperature conditions has yet to be ascertained.

Other roles which the gas turbine is filling, or is likely to fill, include superheating of steam for steam turbines; the generation of auxiliary steam for heating the bunker oil of a steam

power station; the utilisation of heat from nuclear processes, and the burning of natural gas in a Japanese 2,000 kW plant (Japan is apparently also anxious to run gas turbines on blast-furnace gas and coke-oven gas).

The last word in gas turbines comes from the American authors already quoted:—

"In many parts of the world, peak power demands are growing disproportionately to normal demands, thereby creating a market for gas or oil fired gas-turbine plants of low installed cost and medium life and efficiency, especially where remote or semi-automatic operation or end-of-line installation can be used. In some cases, water or steam injection can be utilised to augment the gas-turbine power."

DISTRICT HEATING IN THE NEW POWER PATTERN OF EUROPE

In Czechoslovakia, Poland, Italy, Germany, France, Switzerland, Austria, Denmark and Sweden (and maybe other European countries too) district heating has been welcomed as a practical means of economy in the use of fuel. The rebuilding of European cities after the war presented an opportunity not to be missed—nor was it missed.

Czechoslovakia has over 25 years' experience of district heating. Plans are now being prepared to multiply the number of combined heating and power stations. They will cease to operate as peak-load stations, covering mainly "the middle part of the power consumption diagram." With the advent of atomic power stations it is hoped that within the next ten years power from this source will contribute to district heating. In that event, and assuming that the atomic power station can be located near the heat-consuming centre, economies will be achieved in the transport of fuel and ash, and smoke and dust in built-up areas will be reduced.

Practical difficulties were reviewed in the paper from Czechoslovakia. New designs of heat distribution systems (some of them developed in the United States, Germany and the U.S.S.R.) should lower the high capital cost involved. In dense large cities such as Prague a major problem is the selection of a suitable site for the power-heat station.

Locating the station outside the city, with a long-distance distribution system, has been considered. Hot water at 180 or 200 deg. C. would be the heat-carrying medium. One possible solution is the use of a single-line system, i.e., the used water would not be returned but, if it is not otherwise used in the city, it would be discharged into a river or canal. But in view of the practical difficulties some authorities would prefer the usual double-line system, keeping the length of pipe-lines as short as possible. Whichever system is used there is a calculable lower limit for the capacity of the station below which it would not be economical to build.

In future, Czechoslovakian district heating schemes will employ hot water instead of steam. It is more economical in fuel; it reduces the distribution heat losses from 15 or 20 per cent. to 5 or 10 per cent.; it permits a longer distribution system; and it lowers the cost of consumers' connections. Existing steam systems are shut down during the night, but hot-water systems will operate throughout the 24 hours.

For new towns, before the full electric and heat load is required, district boiler plants are envisaged, using either low-pressure boilers which would later meet peak-load requirements, or high-pressure boilers which would facilitate the transition to combined heating and power plant operation later.

Great importance is attached to district heating in Poland. Two power-heat stations have been built in Warsaw since the war (when 80 to 90 per cent. of the city was destroyed). During the next four years several other towns will be equipped with hot-water systems. Poland has abundant coal, but as coal is needed by the rapidly growing chemical industry it must be husbanded.

About 60 per cent. of the total heating requirements of Warsaw will be met by district heating. Estimated savings are 240,000 tons of coal per annum; 110,000 trips of 3 ton lorries which would otherwise be needed to carry coal and ash if individual central heating were adopted; and a saving in manpower of 600 persons.

Of the two power-heat stations, one is a reconstructed plant and the other is entirely new, with an ultimate capacity of 200 MW together with a heating capacity of 740,000 kcal. per hour. Water is fed at 150 deg. C. and returns at 70 deg. C. Hot water entering a house is first mixed in an ejector unit with part of the returning cooled water so as to reduce its temperature to the desired value. It is then passed through radiators. Air heating is also employed, hot water flowing through a heater over which air is blown. Hot water for baths, kitchen, etc., is supplied by passing the ordinary cold mains water through a heat exchanger.

Apart from these interesting examples from Czechoslovakia and Poland, other papers referred to the use for district heating of exhaust gas from gas-turbine power plants. In Milan the turbines would run on natural gas, in Paris a 10 MW gas turbine will be connected to a waste-heat boiler with a capacity of 150 tons of steam an hour (using the turbine exhaust as preheated combustion air), and in Germany there is a growing tendency for industrial firms to receive electricity and process steam from public supplies. By contrast, the Volkswagenwerk supplies the town of Wolfsburg with heat and electric power.

In Iceland—lucky country!—32,000 of the capital's 62,000 inhabitants have central heating systems fed with natural hot water from thermal wells. A population of 150,000 or more could be supplied in this way.

HEAT-PUMP ENTHUSIASTS ARE HOPEFUL

Heat pumps have so far made slow progress in Britain, but they will show an ever-increasing economic advantage as the prices of coal and oil rise, and as electricity generation becomes more efficient and greater use is made of nuclear energy.

More heat pumps have in fact been made in Britain since the war than is generally supposed, though the number does not compare with the figure for the United States, where the greater opportunity to provide cooling and heating simultaneously has favoured their development and commercial exploitation.

British non-domestic applications include two on ships. Experience suggests that a heat pump is not acceptable on board ship, because of its bulk, unless air conditioning is required. If steam is used for propulsion and electricity generation, it is cheaper to provide steam heating. In the case of a passenger ship, however, the weight of fuel saved by a heat pump would save, in one year, twice the cost of adapting the necessary refrigeration equipment to make it suitable for the heating duty.

Three heat pumps were operating at British power stations in 1955 and two others were being installed. They take heat from the cooling-water river outfall, or from the condensing water on its way to the cooling towers, and they provide heating for offices or workshops. The maximum performance energy ratio (P.E.R.) for these machines ranges from 2·9 to 5·2. (P.E.R. is the ratio of the output heat from a heat pump to the heat-equivalent of the input energy used to drive the motor, including auxiliaries such as pumps and fans). During the conference discussion it was pointed out that plenty of less expensive heat is available at power stations from condensers, generator coolers, or even off-peak electric heating.

The Electrical Research Association's experimental heat pump at Shinfield, Berkshire, is thought to be the largest in the world operating only on the soil as the source of low-grade heat—it abstracts a total of 20 kW under optimum conditions.

The City of Oxford has installed a modern sewage scheme, with electric instead of steam pumps, and the sewage is to be cooled by heat pump to provide heat for a college building.

A prototype pump for drying leather has been developed by the Leather Research Association, and the idea has been taken up for full-scale trial by a major leather firm.

Interest in domestic heat pumps has led the British Motor Corporation to carry out development work with the object of producing heat pumps in quantity at reasonable prices. Development has been concentrated on machines driven by 2 to 5 h.p. motors using special heat exchangers which are very compact and efficient. It is believed that most of the hoped-for reduction in capital costs of heat pumps in Great Britain is likely to result from the use of these heat exchangers. Overall size of the final commercial heat pumps will be about 3 ft. by 2 ft. 6 in. by 3 ft. 6 in.

Domestic heat pumps which give hot water and refrigeration have been marketed in Britain by two companies (Ferranti and Brentford Electric). One of the companies has also made a machine for single-room heating which gives a P.E.R. of 4·0 under average winter conditions.

The main conclusion so far as British domestic use is concerned is that widespread application will depend on the success of the manufacturers in developing a package unit at a price of about £250 for a heating capacity of 10 kW. excluding the heat distribution system. Air would be the source of heat and the P.E.R. would be about 3·0. Local authority housing (main part of the demand) would probably be satisfied with one-room units of 3 kW output.

In view of the coal shortage and Britain's lack of oil or natural gas, it is felt that electrically-driven heat pumps could reduce coal consumption at generating stations to about one-third of that required for direct electric heating, and even to one-seventh of the coal used by an open fire.

But the capital cost is the chief obstacle to a flourishing domestic market. A heat pump using industrial waste heat is more immediately promising. The P.E.R. may be as high as 5·0 or 6·0.

To judge from the papers at the conference, world interest in heat pumps is overshadowed by the more spectacular forms of power. One paper provided practically the whole of the information given in this note—a paper by Miss M. V. Griffith, of the Electrical Research Association, and Mr. John A. Sumner, manager of the Norfolk Sub-Area, Eastern Electricity Board, both in Great Britain,

To be continued

★ ★ ★

During May, 1956, 5,314 million kWh were sold by the Central Electricity Authority to the English and Welsh Area Boards. This was an increase of 2·1 per cent. over the output for May, 1955, although when corrected for weather conditions and working days the figure is increased to 7·8 per cent.

The amount of electricity sent out by the Area Boards during the same month was 5,141 million kWh, and 173 million kWh were also supplied direct by the Central Authority. The increases in the amounts sent out, compared with the corresponding figures for May, 1955, were 2·3 per cent. in the "mainly industrial" and 0·2 per cent. in the "mainly non-industrial" areas.

Letters to the Editor

BOUNDARY LUBRICATION

SIR, The question of efficient oil lubrication of journal and other bearings is of vital importance to engineers. It follows that any further improvement in the application of the hydrodynamic theory of lubrication to such cases is of interest.

In the particular case of viscous flow of a lubricant between a fixed block, AB, and a plane moving surface, CD, inclined at a small angle α radians, the Navier-Stokes equations for a three-dimensional system may be reduced to the simple form:

$$\frac{\partial p}{\partial x} = \mu \frac{\partial^2 u}{\partial y^2} \quad . \quad . \quad . \quad (1)$$

where $\frac{\partial p}{\partial x}$ is the pressure gradient along CD (which is taken as the direction of x positive), u is the velocity component parallel to CD, and μ is the coefficient of viscosity of the lubricant. The value of $\frac{h}{l}$ is assumed to be very small.

Equation (1) depends on the assumptions that there is zero flow in the direction OZ (perpendicular to the diagram) and that inertia forces are negligible; also that the pressure gradient in the direction CA, i.e., $\frac{\partial p}{\partial y}$, may be ignored, since the component velocity v is very small compared to u. Equation (1) may also be derived, *ab initio*, by considering forces, due to viscosity, acting on a fluid element having laminar motion in one direction.

Integrating equation (1) twice and satisfying the boundary conditions that $u = U$ when $y = 0$, and $u = 0$ when $y = h$, leads to:

$$u = U\left(1 - \frac{y}{h}\right) - \tfrac{1}{2}h^2\left(\frac{y}{h}\right)\left(\frac{p'}{\mu}\right)\left(1 - \frac{y}{h}\right) \quad (2)$$

where U is the (constant) velocity of CD in its own plane; $p' = \frac{\partial p}{\partial x}$.

The rate of fluid flow in the direction CD, per unit depth perpendicular to the diagram, is given by:

$$Q = \int_0^h u\,dy = \frac{h}{12}\left\{6U - h^2\left(\frac{p'}{\mu}\right)\right\} \quad . \quad (3)$$

i.e.,

$$p' = \frac{\partial p}{\partial x} = 12\mu\left(\frac{U}{2h^2} - \frac{Q}{h^3}\right) \quad . \quad . \quad (3a)$$

Integrating equation (3a) to find the pressure intensity p_x at a point distant x from C, noting that $p_x = p_0$ when $x = 0$ and when $x = l$, it is found that:

$$p_x = 12\mu\int_0^x\left(\frac{U}{2h^2} - \frac{Q}{h^3}\right)dx$$

$$= p_0 + 6\mu U\int_0^x \frac{dx}{h^2} - 12\mu Q\int_0^x \frac{dx}{h^3} \quad (4)$$

and

$$Q = \frac{U}{2}\left[\frac{\int_0^l \frac{dx}{h^2}}{\int_0^l \frac{dx}{h^3}}\right] \quad . \quad . \quad (5)$$

It is well to bear in mind that the block AB is not necessarily plane, so that the height h of the fluid wedge is a variable quantity to be fixed by the geometrical conditions in any given case. Equation (4) gives the pressure distribution p_x along CD and equation (5) gives the rate of fluid flow between AB and CD, as soon as h can be expressed as a function of x.

The special case of a plane block AB, as shown in the illustration, can be treated as follows:

From the diagram it is clear that

$$h = (a - x)\tan\alpha = (a - x)\alpha, \text{ very nearly.}$$

The following results apply:

$$\int_0^l \frac{dx}{h^2} = \frac{l}{a(a-l)\alpha^2}; \quad \int_0^l \frac{dx}{h^3} = \frac{l(2a-l)}{2a^2(a-l)^2\alpha^3}$$

$$\therefore Q = U\frac{a(a-l)\alpha}{(2a-l)} \quad . \quad (5a)$$

$$\int_0^x \frac{dx}{h^2} = \frac{x}{a(a-x)\alpha^2}; \quad \int_0^x \frac{dx}{h^3} = \frac{x(2a-x)}{2a^2(a-x)^2\alpha^3}$$

and, with Q as in equation (5a):

$$p_x = p_0 + \frac{6\mu U x(l-x)}{h^2(2a-l)} \quad . \quad (4a)$$

The mean pressure intensity p_m over CD must satisfy the relation:

$$\left.\begin{array}{l}\text{Total fluid force in}\\ \text{direction CA}\end{array}\right\} = \int_0^l p_x\,dx = p_m \times l$$

i.e.,

$$p_m = \frac{1}{l}\int_0^l\left[p_0 + \frac{6\mu U x(l-x)}{h^2(2a-l)}\right]dx$$

$$= p_0 + \frac{6\mu U}{l(2a-l)\alpha^2}\int_0^l \frac{(lx - x^2)}{(a-x)^2}\,dx$$

$$= p_0 + \frac{6\mu U}{l\alpha^2}\left[\log_e\left(\frac{a}{a-l}\right) - \frac{2l}{2a-l}\right]$$

$$. \quad . \quad . \quad (6)$$

When expressed as a gauge pressure the term p_0 in equation (6) is ignored.

Numerical Example

Take $a = 2l = 8$ in. $= \frac{2}{3}$ ft.; $l = 4$ in. $= \frac{1}{3}$ ft. $(a - l) = 4$ in. $= \frac{1}{3}$ ft.; $(2a - l) = 12$ in. $= 1$ ft. U $= 30$ ft. per sec.; $\alpha = 0{\cdot}001339$ radian, corresponding to $h_m = 0{\cdot}008$ in.; $\mu = 8 \times 10^{-4}$ ft.-lb.-sec. units.

Then, as a gauge pressure, equation (6) gives:

$$p_m = \frac{6\times 8\times 10^{-4}\times 30}{\frac{1}{3}\times 0{\cdot}001339^2}\left[\log_e\left(\tfrac{3}{4}\right) - \tfrac{2}{3}\right] \text{lb. per sq. ft.}$$

$$= \frac{18\times 240}{144\times 0{\cdot}1339^2}\left(\log_e 2 - \tfrac{2}{3}\right) \text{lb. per sq. in.}$$

$$= 44{\cdot}313 \text{ lb. per sq. in.}$$

The values in this example are the same as those given in the footnote on page 90 of Dr. J. Kestin's English translation of the excellent treatise, *Boundary Layer Theory*, by Dr. Hermann Schlichting. The latter's estimate of p_m by an approximate method gives $p_m = 41{\cdot}7$ lb. per sq. in., which is 5·89 per cent. low compared with the value found as above.

It would appear that equation (6) is new. The integration involved presents no difficulty.

Yours faithfully,

L. E. ADAMS,
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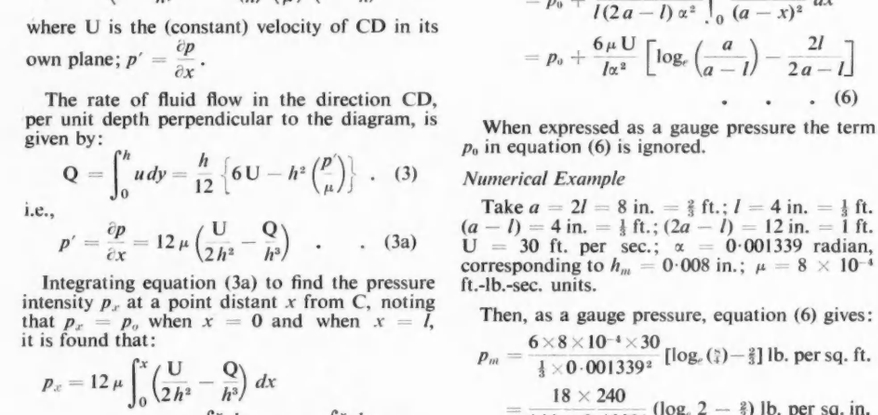
Kingston Technical College,
Surrey.
June 19, 1956.



(3692.) "ENGINEERING"

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BRITANNIA BRIDGE

SIR, The article, page 386, in your issue of May 25, 1956, about Joseph Stenson and the Britannia Tubular Bridge, interested me considerably. There was a further reference to this great bridge in your contemporary, *The Railway Gazette*, of April 20, 1956, and at that time that paper reproduced a slide of the well-known picture of the meeting of the Britannia Tubular Bridge Council.

One of my grandfathers left me a copy of this picture. G. P. Bidder—one of the figures in it—was my great-great-grandfather. The real point of interest for me, however, lies in the name Edwin Clark. Although I am not aware of any family connection I have always wondered who Edwin Clark was and it occurs to me that some of your readers might be able to throw some light on him. I notice that in the article in your journal that the name Clark was spelt Clarke by Joseph Stenson. On the other hand the key to the picture, which I have, shows it spelt in the same way in which I do.

Yours truly,

EDWIN F. CLARK
North British Locomotive Company, Limited,
Springburn,
Glasgow, N.1.
June 28, 1956.

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Obituary

MR. H. E. MIDGLEY

We regret to record the death of Mr. H. E. Midgley, which occurred at Wargrave-on-Thames on July 1 at the age of 76. Although in his earlier years he had been connected with electricity supply and the design and construction of steam turbines, he later turned his attention to the commercial side of the industry and served on the boards of a number of important companies.

Harold Edward Midgley was born at Wetherby, Yorkshire, and was educated at Wakefield Grammar School and Queens' College, Cambridge. After a short time in the York Electricity Department he joined Callender's Cable and Construction Company at Erith and subsequently served as mains engineer and deputy engineer in the Electricity Department in that town.

In 1909 he became chief assistant in the Turbine Department of Fraser and Chalmers, while ten years later he obtained a similar appointment with Dick, Kerr and Company and subsequently was placed in charge of the Power Section of the English Electric Company as project engineer. He served as chief engineer and manager of the Foundation Company, Limited, from 1921 to 1928 and as managing director of Ruths Steam Storage, Limited, from 1928 to 1930. From 1930 to the date of his death he was vice-chairman of Newton Bros. (Derby), Limited, and from 1934 to 1937 chairman and managing director of the Brush Electrical Engineering Company, Limited. On relinquishing the latter positions he retained his seat on the boards. He was also chairman of the Dammann Asphalt Company and a director of Scott Insulated Wire Company.

Mr. Midgley was elected an Associate Member of the Institution of Civil Engineers in 1905 and was transferred to the class of Members in 1919. He joined the Institution of Mechanical Engineers in 1911 and became a Member seven years later. He was elected a Member of the Institution of Electrical Engineers in 1920.

Weekly Survey

Cover Picture: *Casting is one of the oldest methods of manufacturing items both in metal and in other materials, and the art has grown through the ages. In many foundries to-day some degree of mechanisation has been attained by mounting the ladles from overhead runners or cranes, and by bringing the moulds to the ladles on roller conveyors. The actual pouring of the iron into the mould is still one of the craftsman's jobs. In the illustration, iron is being poured into a mould, the top of which is held down by a weight to prevent lifting by the inflowing metal.*

* * *

Krupps and Hoesch on German Problems

The struggle for engineering exports is becoming keener. British engineering concerns are not alone in being faced with difficulties in the export market, and in exhorting people to "look at the Germans" it would be well to bear in mind that manufacturers in Germany are faced with much the same problems as their British competitors, as two recently published annual reports show.

Generally speaking, the Friedrich Krupp concern, which embraces shipbuilding, locomotives and a wide variety of engineering work, was faced with a sharp brake on its export trade in the year ending September 30, 1955. From 1949/50 to 1953/54, the Krupp group's exports rose from DM 50 million (£4·3 million) to over DM 260 million (£23 million). In 1954/55, however, there was a perceptible slackening in this trend, which the Krupp directors attribute to increasing competition, import quotas and lack of capital from the German money market. "It seems vital," comments the report, "to find new ways of providing long-term export finance if Germany is not to lag behind foreign competitors." Exports of the group reached DM 280 millions (£24 million) in the year under review, but the greater part of this increase was accounted for by the efforts of the shipbuilding subsidiary, A.G. Weser of Bremen. Totalling some 150,000 tons deadweight, 22 ships were delivered during the year and of this tonnage 50 per cent. went abroad. Meanwhile orders on hand totalled 60 ships of some 660,000 tons for delivery dates ranging up to 1959. Despite the difficulties of the export market, however, shipbuilding was not the only notable contribution to the group's prosperity. As well as the construction of the Rourleka iron and steel works in India, the concern has many other projects on hand in under-developed countries. Meanwhile at home new projects include Diesel engines, man-made fibre machinery, heavy presses and titanium extraction from the sponge. Turnover in the electrical machinery sector rose by 22 per cent., and in pneumatic tools by 66 per cent. Indeed the only plant where capacity was not fully utilised was in the locomotive works, where the German company appears to be sharing in the general recession in steam locomotives.

Hoesch Werke A.G., whose principal activities are in coal and iron, have another explanation for the slackening in exports of their products. They attribute it mainly to the conflicting needs of the home market, where supplies of steel, iron and coal are still vainly attempting to keep pace with the rise in demand. The extent of this is shown in the group's order book, which reached DM 1,519 million (£130 million) in 1954/55—a 22 per cent. increase over 1953/54, and DM 500 million (£42·5 million) more than in 1952/53. While order books are full, and capacity is being utilised up to the limit, Hoesch Werke are not without their difficulties. Two of them, namely the difficulty in recruiting labour and its drift from the mines, can be well understood in this country. A third problem is that of the consequences of controlled prices. The European Coal and Steel Community's fixed maximum price policy is not favourable to this vertically integrated concern. Ruhr coal is the cheapest within the Community, and Germany is faced with the anomaly of sending cheap coal to Belgium and France while having to import expensive coal from overseas to meet its own needs. At one stroke, this must raise costs and lower profit margins at a time when gross profits must be kept high to increase the amount of capital expenditure per annum as the labour problem becomes more acute. Germany, like the U.K., must spread its available labour thinly to keep output high.

* * *

Foreign Orders for German Defence

The Defence Committee of the Western German Government has recommended the expenditure of £600 million on armaments and it is likely that its views will be endorsed by the Government before this issue appears. Over £300 million of contracts is expected to go abroad at the rate of about £100 million a year. This figure does not include artillery, tanks and electronic equipment, where there is to be a trial period before the German Services standardise on particular makes. It would appear from the published list of equipment which is being bought from abroad that this country is not going to be one of the major beneficiaries. It looks as though the Americans are about to reap some reward for their substantial investment in armaments for Germany as some of the items which were given free to that country are now to be ordered as standard equipment.

There is more than a little irony in this situation. No one would deny the Americans' right to expect some return on their enormous investment in the defence of Western Europe. There was always the implication in selling the idea to the United States Congress that United States military aid would in the end be good business as well as good strategy. The position in this country is less fortunate. A few years ago it assumed a larger burden than any other European country in building up the defences of the West. The price at the time was inflationary pressure at home and the forfeiture of export markets abroad, not least to Germany. Now, the British defence effort is to be rewarded with a much smaller share of the foreign German contracts, at least proportionately to effort, than either France or Italy. One of the biggest disappointments is the United Kingdom's failure to get a contract for the Hawker-Hunter. The Germans have preferred to order the American F100D fighter because its precursor the F84 has already been supplied as a gift to the German Air Force. This order alone is worth £80 million. The balance may be restored in due course when the rest of the equipment is standardised but meanwhile there will be some bitter thoughts about the price which has to be paid for being a good European.

* * *

High Speeds by Small Cars

International long-distance speed records, set up by specially built cars, or by highly tuned sports racing models, usually hold only academic interest for the engineer, and still less for the ordinary motorist, but recent record runs at Monza by a Fiat 600 modified by Abarth are of more general interest as the mechanical parts used were basically those of the normal Fiat 600 saloon. The car now holds 750 c.c. class records for 3,000 km., 24 hours and 4,000 km. at speeds up to 98 m.p.h., records up to 48 hours and 10,000 km. at over 90 m.p.h. and records for 10,000 km. and 72 hours, never before achieved by a car of this size, at over 87 m.p.h. Suspension, steering, stub axles and wheel bearings successfully stood up to days and nights of pounding at 95 to 100 m.p.h. on the banked track, and ordinary Michelin touring tyres successfully withstood twice the normal speeds.

The engine, enlarged to 747 c.c. by increased cylinder bore and a long-throw crankshaft, had a larger carburetter, higher-compression ratio, lighter valves and double valve springs, raising the power to 42·5 b.h.p. at 5,400 r.p.m. against the standard 21·5 at 4,600 r.p.m. With a streamlined single-seater body having a projected frontal area of 11·8 sq. ft., the car proved capable of 109 m.p.h., reproducing the calculated performance almost exactly, and its fuel consumption at a steady average of 93 m.p.h. was over 50 m.p.g., completing a striking demonstration of the stamina and economy of the modern small car.

The attempt showed however, that the rear-engined arrangement, while perfectly adequate for small touring cars, presents difficult problems when high speed are contemplated. With engine, transmission, fan and radiator grouped at the rear, the car had about 60 per cent. of its weight on the rear wheels. When associated with a finely streamlined body, with the driver fully enclosed, this produces a car in which the centre of pressure is well ahead of the centre of gravity, and it is therefore excessively sensitive to disturbing forces. Scaglione, the Italian specialist who designed the body tackled the problem in two ways; by shaping the nose to produce some aerodynamic loading on the front wheels at the designed speeds, and by using a fairly large tail fin. When tried without the fin, the car was very difficult to control, and even with it, the steering was rather sensitive.

Achievement of efficient cooling without excessive drag demanded considerable study. The normal Fiat cooling arrangement was used, with the radiator alongside the engine, and a belt-driven fan forcing air forward through the matrix, from which a duct led it away beneath the car. (The matrix was increased in size to cope with the extra requirements of the more powerful engine.) An air-intake aperture in the rear deck dropped the speed by 3 m.p.h., so thousands of small holes were pierced in tail fin and rear deck, giving the effect of a porous skin, which gave a large effective area, and no measurable loss of performance. It was found that airflow from the rearward facing exit under the car was being restricted by eddies, so this too was faired off with perforated sheet metal, dropping the temperature by 8 deg. C. and raising the speed by 2 m.p.h. During the night some of the intake area had to be blanked off with adhesive tape, as temperatures fell so low that speed was being reduced.

Demonstrations of this kind suggest the possibilities of fast, economical travel that are within our grasp if only we had a modern road system, permitting designers to adapt gear ratios and body shapes for continuous fast cruising rather than for intermittent movement in traffic blocks.

* * *

Oil Pipeline for Europe

The Royal Dutch-Shell Group has now announced that it is studying a project for building a 30 in. pipeline from Marseilles north to Wilhelmshaven on the North Sea. It has envisaged at the moment that the line will, in fact, fork near Cologne, one branch going on to Antwerp and Rotterdam and the right-hand one going through Germany along the German-Netherlands border to Wilhelmshaven. It seems possible that branch lines will run to Paris and Strasbourg. The provisional estimated cost is about £100 million.

This is a bold scheme. It would provide a commercial connection overland between Marseilles and the North Sea ports and also with northern France and south-west Germany. It comes at a time when a final decision has got to be made about the terminal point for the Ruhr pipeline and also when the German Government has approved a major dredging operation for Wilhelmshaven. The scheme itself would clearly economise in the use of tankers which are likely to be scarce and expensive for some time to come. It would enable the oil refineries to pursue a more flexible policy in the siting of refineries. Under the scheme, somewhere between 25 and 30 million tons of crude oil a year could be moved by pipeline from Marseilles to the indus-

trial Rhine basin and environments, representing a large proportion of the expected demand for crude oil over the next few years. The plan does not envisage the piping of oil to the United Kingdom but once the terminal reached Rotterdam or Paris, an underwater line might be a project worth considering. Meanwhile, the pressure on tanker tonnage from the Middle East to the U.K. would be noticeably eased, though careful thought is necessary before making the U.K. too dependent on the friendly disposition of her continental neighbours.

Apart from the commercial implications of the plans, there are important strategic considerations. In theory, pipelines, unless buried, are weak defence lines to hold and invite sabotage in times of war. In practice the theory has never been as yet fully tested by experience. There remains, however, the problem of how far the West, in particularly Britain, should rely for its crude supplies on a lifeline of this kind. A complicating factor is the pipeline system laid as part of the N.A.T.O. defence system. Presumably, there will be little difficulty in coupling the N.A.TO. system on to the new line.

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Heating and Ventilating Engineers at Harrogate

At the summer meeting of the Institution of Heating and Ventilating Engineers, held at Harrogate from July 1 to 3, a large number of members and guests took part in a programme which included the presentation of two technical papers on subjects outside the scope of members' normal work but of considerable importance to them, works visits, the Institution's annual banquet, as well as other social events.

The first of the technical sessions saw the presentation by Mr. M. H. Ewbank, B.Sc., A.C.G.I., of an address entitled "The Future of Nuclear Power," in which he summarised present world energy requirements and surveyed the trend in this connection. The second paper was by Mr. R. G. Veryard, of the Meteorological Office. Under the title "Can the Meteorological Office Help You?" Mr. Veryard gave a summary of the organisation of the Department and then described in detail some of the work it does. He pointed out that it was generally believed that the Meteorological Office was solely concerned with the provision of weather forecasts, whereas in fact, of the twelve Divisions of the Department, less than one half were directly concerned with forecasting. One of the important duties of the Meteorological Office was that of consultant in all matters relating to weather and climate, and it had a special section, the Climatological Services Division, which was responsible for this work. Meteorology had an important effect on almost every form of human activity, and as Mr. Veryard pointed out, engineers came into the picture prominently; the water, power generation and transport industries, for example, were all affected by the meteorological environment, and of course the interest of the heating and ventilating engineer in the subject was very obvious. To enable the Divison to manipulate and combine data quickly, machine methods are being brought into more extensive use. The machines will provide a rapid method of sorting and assembling data—one other thing is needed, information on the sort of weather data needed by the heating and ventilating engineer.

Three nearby establishments were open to visitors from the conference; though engaged in three very different activities, each provided interesting examples of engineering practice. At the Yorkshire Copper Works, Limited, Leeds, the production of solid-drawn non-ferrous tubes from 0·005 in. bore to 24 in. in diameter was seen, together with the manufacture of rigid and flexible plastic tubes and the well-known "Yorkshire" capillary fittings. In the works of Montague Burton, Limited, Leeds, the visitors were shown both the production departments, employing 8,000 workers and claimed to be the largest clothing factory in the world, and the boiler and switch rooms which provide steam for process work and heating, and control the ventilation. Not the least interesting part of the visit was to the canteen, which accommodates 8,000 people at one sitting, and can serve 1,000 cups of tea a minute.

A very different type of establishment visited was the headquarters of the Fibres Division of Imperial Chemical Industries, Limited, on the outskirts of Harrogate. Here, in a 175 acre site, buildings have been erected to house the administrative, technical service and research departments which comprise the Fibres Division and employ, at present, over 700 people. At this centre, which is conveniently near to the textile manufacturing centres and to the I.C.I. plant at Wilton, are concentrated the administration of and research into the two man-made fibres produced by I.C.I., "Terylene" and "Ardil." No production is carried out at Harrogate, but there are machines of various kinds for experimental work. Harrogate is famed as a spa and resort, set in beautiful countryside, and the buildings have been designed to provide all the facilities required by the Company without in any way interfering with the local amenities.

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Fixed Prices in Industry

Gradually—and perhaps surprisingly—evidence is building up that industry is taking seriously the Government's attempt to stabilise prices. First the cement manufacturers announced that their prices would be held for one full year, and then other manufacturers of building materials followed their lead, including manufacturers of metal windows, stock bricks and Redland tiles. In other industries well known companies such as Qualcast, Ransomes, Sims and Jeffries, Johnson Matthey, United Glass Bottle Manufactures Reckitt and Colman, Tootal and others have answered the Prime Minister's call. During the next few weeks there will be meetings of the Federation of British Industries, the National Union of Manufacturers and the British Employers' Confederation. At these meetings the attitude of industry should be clarified.

The Government feel that if prices can be stabilised in the private sector of industry as well as in the nationalised ones, this should be a powerful inducement to the trade unions to co-operate. There is also little doubt that a public commitment not to increase prices would give the companies concerned a powerful lever in resisting any substantial new wage demand. Union leaders and shop stewards have been quick to point this out, and have labelled the Government's policy a deliberate attempt to undo all progress made since the war in the levelling-off of incomes and earnings. Already the railwaymen have challenged any attempt to impose a wage-freeze; the miners and builders are expected to do the same. Mr. Arthur Horner, General Secretary of the National Union of Mineworkers said at the union's annual conference last week that if the N.C.B.'s price stabilisation policy meant that the Board "had to oppose the miners' demands for improved conditions" they would resist it.

The Government's main hope for the success of their policy lies in the wholehearted backing of private industry. If this takes place, and the rise in the retail price index is halted, union leaders may get the support they need to make the policy effective. But more than this will need to be done; profits, and particularly distributed profits, will be under fire just as much as wage increases. The price to be paid for price stabilisation may be greater than either side of industry is willing to pay.

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Investment Still Rising

In his review of the economic situation last week, the Chancellor of the Exchequer, Mr. Macmillan, said it was forecast that investment in private industry would rise this year another 15 per cent. on top of the 20 per cent. by which last year's figures exceeded those of 1954. Private manufacturers had, surprisingly, revised their 1956 estimates upward in their latest returns, and there is a continuing rise in the orders placed for machine tools. "That is not much sign of a slump, anyway," Mr. Macmillan commented. This was in reply to Mr. Harold Wilson's "economics of Bedlam" attack on Government economic policy which arose particularly from the troubles facing the motor industry. The Chancellor admitted that there were signs now of a weakening in the intensity of the boom, but added: "Because there are one or two weak spots, it would be very wrong to think we are in danger of a general recession."

This optimistic view received confirmation from two sources. In his annual statement to shareholders, Lord Bruce, chairman of the Finance Corporation for Industry, said that the fears expressed earlier this year of a large cut back in the corporation's new operations had proved unjustified. By the end of March they had undertaken to make further investments amounting to £39·6 million compared to £32·8 million during the previous year. As in the case of the I.C.F.C. (Weekly Survey: June 22, "A Brake on Enterprise") there is no sign of any abatement in industry's wish to invest, and the corporation had been in a position to choose those "ventures which would benefit the national economy." Information published in the Board of Trade Journal last week-end confirms Mr. Macmillan's statements that capital expenditure this year by manufacturing industry will exceed earlier forecasts. The revised estimates indicate that the total will be 20 per cent greater than in 1955, against an earlier forecast of 17 per cent. Investment on plant, machinery and vehicles is expected to be 18 per cent. higher and that on buildings 32 per cent. higher. Shipping companies expect an increase of 10 per cent. in their investment, whereas no change had been expected.

These are certainly not symptoms of an ailing economy. The boom is still on, and if the rate of climb is slowing down somewhat there is more cause for satisfaction than dismay—always provided major industrial strife can be avoided.

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Fishing to Call on Engineers

Around 50 years ago no engineer would have been prepared to concede that farming mechanisation, with all the modernisation in planning and production that has gone with it, would become a major element in the engineering industry, yet this has happened. It is a thought to conjure with that by the end of this century fishing may have a similar effect. The basic impetus might be provided by the need to raise the protein content of the diet in many of the under-developed territories of the world, especially in the tropics. Fish may get through to localities which are beyond the economic transportation of fresh meat. A hint that events are moving in this direction comes from the decision to hold an international symposium on chilling of fish at Rotterdam last month. A meeting of 80 fish processing technologists from 18 countries was held under the auspices of the Fishery Division of the Food and Agricultural Organisation of the United Nations. The same body is also sponsoring an International Fishing Gear Congress to be held in October, 1957, in Hamburg, Germany.

The Rotterdam meeting forms part of a programme by F.A.O. to treat fishing as farming. Only some 10 per cent. of the world's animal protein food consumed by man comes from the water which covers 75 per cent. of the earth's surface. At present the total fish catch of all types is about 27 million metric tons a year which represents an increase of about 7 million metric tons over 1938. One marine biologist has estimated that the total might be raised to 50 million tons a year in the next 20 years. A more intensified working of the world's fishing grounds would require a good deal of survey work but the need which exists to raise the

standard of diet throughout the world and the opportunities which may develop to use fish for that purpose make it possible that fishing may yet play a very much larger part as an outlet for engineering equipment than it does at present. There is still scope not only for an increased tonnage of shipping vessels but also for increased attention to design to meet the special requirements of tropical fishing conditions and parallel developments in the engine field; and certainly shoal tracking and perhaps even catching will make more extensive demands on the makers of electronic equipment.

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Gas in Western Europe

An important role is claimed for the gas industry in the problem of the fuel gap which is expected to develop over the next two decades. The case is set out in a study by the Economic Commission for Europe called "The Trend of the European Gas Economy." The advantages of gas are its high degree of efficiency in a form readily adaptable to automatic feeding and control devices, and the scope which thereby exists for saving labour. These are two important arguments for developing gas in the next 20 years. Furthermore, the future for gas lies mainly in heat production and chemical uses where nuclear energy is unlikely to develop, at least in the early stages. Competition between gas and nuclear fuel is thus likely to be late rather than early.

Three main problems have to be overcome to bring about a large expansion of the gas industry in Western Europe. First, flexible units operating independently of coke ovens and producing gas at an economic price from coal have to be established. Second, such units have to be combined with coke ovens, existing gas works and possibly natural-gas reserves. Third, such units should be connected by a long-distance transport system, possibly with the installation of underground storage capacity. If these problems could be solved, two of the main drawbacks of gas would be overcome, namely, its close connection to its sources of supply rather than to its potential markets, and the inability of one gas system to supply another at peak times—a type of flexibility which electricity authorities are learning to exploit more fully. If it were possible to establish units independant of coke ovens, the use of coal, black oils and natural gas as alternative raw materials could be more fully exploited.

Taking Europe as a whole, including Russia and its satellites, the recent rate of expansion of gas capacity is expected to continue at the same rate in the immediate future. Between 1953 and 1960 the compound rate of increase is expected to be as high as 34·4 per cent. in the Soviet Union and as low as 4 per cent. in France and 2·1 per cent. in the U.K. Generally speaking the planned rate of expansion is high behind the Iron Curtain and in Italy. Italy is rapidly extending its natural gas industry. In contrast, the industrialised countries of Western Europe plan only small rates of increase, largely, no doubt, because their gas industries are already extensively developed. Overall, the report considers that in terms of immediate economic and technical problems the current rate of increase of capacity is about right. It thinks, however, that in terms of a fuel policy over the next two decades the rate of increase should be stepped up since the fuel gap may develop more quickly than new capacity could be installed for the gas industry when the need becomes urgent.

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National Inspection Council for Electrical Contracting

Shortly after Vesting Day, the (then) British Electricity Authority proposed that the existing National Register of Electrical Contractors should be reorganised to include an extended installation inspection service. As a result, an Organising Committee representative of various electrical interests was set up in 1950 under the chairmanship of Mr. P. V. Hunter and subsequently reached the unanimous decision to set up a National Inspection Council. The organisation that has now been accepted for this purpose is a two-tier structure: the National Board, which is the executive body, and the National Council. The former consists of 16 members drawn from the technical interests represented on the Organising Committee and, in addition, representatives of the Royal Institute of British Architects, the Associations of Consulting and Supervising Electrical Engineers, and the South of Scotland Electricity Board. Mr. P. V. Hunter has been elected chairman and Mr. C. R. King deputy chairman.

The National Council will consist of representatives of bodies interested in both the technical and consumer aspects of electrical contracting. The former will include the British Electrical and Allied Manufacturers' Association, the British Electrical Development Association and the British Standards Institution, while on the consumers side will be the Federation of British Industries, the National Farmers' Union and the National Union of Manufacturers. It is also hoped that representatives of the Ministers primarily concerned in the work of the Council will attend, at least as observers. Local committees will be set up in the area of each Area Board, and will display a list of Approved Contractors at all their Service Centres. "Rules relating to Enrolment on the Roll of Approved Electrical Installation Contractors" are in draft and should be available by time the Memorandum and Articles of Association of the Council have been approved by the Board of Trade. The chief executive and secretary of the National Board is Brigadier W. G. S. Thompson, O.B.E., and the offices of the National Inspection Council are at 13 Victoria-street, London, S.W.1.

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Organising Research

Increasing severity in international competition and the pressure of expanding populations have intensified the need of all nations to improve the range, flexibility and technology of their industries, both existing and prospective. To aid in this work, many countries have been led to set up research establishments of various kinds, ranging from the completely voluntary to those entirely dependent upon government grants. In Britain, where the first research association was formed as long ago as 1918 and is still active, there are now 14 national laboratories under the Department of Scientific and Industrial Research and nearly 50 research associations receiving grants from the Government, as well as many other bodies outside the Government scheme.

Both here and in countries oversea, the acute shortage of scientists makes the good management of these establishments and their staffs a matter of special importance. Such problems as the choice of projects for research, of when and how to stop research, and the adequate use of technicians and facilities, are matters meriting the most careful consideration. To provide a focus for thought on these and similar subjects, an international symposium on "The Direction of Research Establishments" has been arranged by the National Physical Laboratory, Teddington, Middlesex, and will be held there from September 26 to 28 next. The symposium, which is understood to be the first international conference on science administration in Britain at which representatives of government bodies and private concerns will be able to exchange experiences, is intended for administrators whose special responsibilities lie in the direction and management of large research organisations. The official language will be English and it is expected that the symposium will be attended by scientists from the United Kingdom, other Commonwealth countries, the United States and several European states.

The opening speakers, who will deal with the selection of research projects, will be Professor J. D. Bernal, F.R.S., Professor of Physics in the University of London, and Dr. Willis Jackson, F.R.S., director of research and education to the Metropolitan-Vickers Electrical Company, Limited. Extended discussions will follow on developing the creativity of scientists and the administrative control of their work. On the second day, three parallel groups will discuss, respectively, methods of internal organisation, staff arrangements, and problems of communication. The final session, on the methods by which the work of a laboratory can be assessed, will be addressed by Mr. A. H. Wilson, F.R.S., chairman of the industrial research committee of the Federation of British Industries. Communications should be addressed to the organiser of the symposium, Mr. E. S. Hiscocks, secretary of the National Physical Laboratory, and copies of the *Proceedings*, including papers and summaries of discussions, will subsequently be obtainable from H.M. Stationery Office.

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Selecting Technical Managers

The man who is able to combine technical know-how with managerial skill is as hard to find in the United States as in this country. A great deal is being done, however, to tackle this problem of selection in a logical, scientific manner, and with good results. In a paper read to the American Society of Mechanical Engineers last month, Mr. A. Pemberton Johnson of the Newark College of Engineering suggests a simple basic approach which could be employed anywhere: (1) define clearly the key duties to be performed, and, if possible, find out the personal attributes of men who do them well; (2) find out the "management climate" surrounding the position to be filled; and (3) appoint the man whose qualities and qualifications come nearest to the job specification, "who would be happy in the management climate involved."

Compatability with staff above and below, and the ability to encourage as well as bring down to earth other engineers, rank high in Mr. Johnson's specifications. A technical manager must have the expertise his position demands, but above all be a wise and balanced person, with literary interests and sound economic sense. He quotes a recent psychological study of the predominant qualities in top executives earning 20,000 dollars a year or over: "these men were all healthy, well-rounded individuals who derived a great deal of their job satisfaction from the growth and development of their companies. They had a good many lasting friendships, high moral and religious standards, high intellectual abilities, and interests that were primarily persuasive, literary and computational in nature, rather than mechanical or scientific." Another study which included two levels of managers who were primarily technical managers, showed "the same widespread normal distributions of personality."

Mr. Johnson attaches great importance to the candidate's wife, who can be "a great help in his transition from specialist to technical manager." He urged on companies a long-term programme of sponsoring the self-development of young technical men toward management responsibility, and of trying them out systematically in positions of increasing responsibility. He also recommends the use of psychological tests to determine the ability of the scientist or engineer to become a manager. There was the familiar emphasis on the ability to stimulate useful thinking in subordinates, delegate responsibility and authority and instill economic realism in the designers and engineers who work under him. This type of approach to a problem which faces most managing directors of engineering companies is both useful and stimulating.

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Qualifications of Distributors

It seems not unfitting that the question of the recognition of machine tool merchants should have come to the fore in connection with a

Council meeting of the Association of Engineering Distributors held during the period of the International Machine Tool Exhibition. The matter was brought forward in a luncheon address preceding the meeting by Mr. B. E. Cash, managing director of T. S. Harrison and Sons, Limited, Heckmondwike, Yorkshire. In his speech, on the distribution of machine tools from the point of view of a manufacturer, Mr. Cash said he had noticed that no fewer than 85 of the Association's total membership were rated as machine tool distributors, although several of these firms were not known to him and, in the opinion of his own company, some of them were not entitled to so describe themselves.

To qualify for recognition, merchants should not only carry stocks but be able to render technical assistance to their customers and, Mr. Cash said, it should be a function of such a body as the Association to see that manufacturers were well informed as to which firms might properly be given quotations as merchants. It sometimes happened that merchant firms asked his company to attend to user's machinery at a considerable distance from its works and when the distributors themselves were close at hand. In such cases, it would be helpful to have some indication of the trouble that had arisen. The policy of his company was to support the distributing trade and he considered that that was the aim of machine tool manufacturers generally, but sometimes manufacturers considered that they should receive more co-operation from the merchants. He considered that there was no justification for granting discounts to educational establishments. Machines supplied to schools, for example, frequently required considerable servicing. He would not like to be involved in schemes for stopping deliveries to merchants who cut their prices. The remedy for present ills seemed to lie in a system of graded discounts, coupled with strong action by the Association to see that supplies did not go to people who were not entitled to them. At the ensuing Council meeting, held, like the luncheon, at the Park Lane Hotel, London, it was decided that no useful purpose would be served by taking any further action in connection with the Restrictive Trade Practices Bill at the present time. Another matter brought forward was the need for an "honest trading policy," to prevent the cutting of merchants' discounts, and it was suggested that area meetings of distributors should be held to consider pricing policy.

It was announced that the annual general meeting would be held on October 23 at the Park Lane Hotel, when an address would be delivered on stock control. The Association, which was formed in 1942, covers six sections of engineering distributors, ranging from machine tools to raw materials; its headquarters are at Hastings House, Norfolk-street, London, W.C.2.

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The Whitworth Society's Summer Meeting

That the substitution of Whitworth Fellowships in place of Whitworth Scholarships is not universally approved was made evident in the course of a dinner at the Engineers Club, Manchester, on June 26. This function was the first item in this year's summer meeting of the Whitworth Society. Some of the older members did not approve of the abandonment of Whitworth's original intention that his scholarship should encourage artisans to "study theory." As has many times been made clear, the original form of the Whitworth Foundation has outlived its usefulness owing to widespread introduction of state and county scholarships of various kinds which are much more easily won; competitions for Whitworth Scholarships has been disappointing in recent years.

An objection of a more domestic nature, which was raised, was that as only two or three Fellowships were to be awarded each year, the size of the pool of Whitworth men would gradually decline leading to the ultimate extinction of the Whitworth Society. This consideration is not likely to have much influence on the Ministry of Education which determines the nature of the Whitworth awards, but has always given proper consideration to views put forward by the Whitworth Society. In this particular connection, it is not to be overlooked that the new regulations allow of the award of six Whitworth Prizes each year. These are of the value of £50 which is the same as that of the old Whitworth Exhibitions, although under modern conditions that value is far from being what it was. It was stated that only some four or five theses in competition for Whitworth Fellowships have been received this year. This, however, is probably to be explained by the fact that the Fellowships are not yet widely known, rather than an indication that they are not attractive.

This Engineers Club dinner was merely a preliminary item in the Whitworth Society summer meeting. The main feature was a visit to the works of the Metropolitan-Vickers Electrical Company. In the course of luncheon provided by the company, Dr. R. W. Bailey retired from the presidential chair and inducted the new president, Mr. P. L. Jones. Both these gentlemen carry on a tradition of which the Whitworth Society is proud, and which it has many times been able to follow, that its presidents shall be ex-Presidents of the Institution of Mechanical Engineers.

To attempt an adequate description of the remarkable Trafford Park works of the Metropolitan-Vickers Company in a brief space would be futile. When they were established by Geore Westinghouse in 1899, the buildings covered 30 acres of a 100 acre site. Additional land has been acquired and the works now occupy 160 acres with a shop floor area of 3,194,135 sq. ft. in the main works alone. The most impressive features of the original shops were the two main aisles 900 ft. long. One of these has now been extended by 256 ft. and the second is in process of being similarly treated. In these aisles heavy electrical plant and steam turbines are built. These shops and the foundry, 600 ft. long, together with the welding shops formed some of the most interesting items seen during the visit. Some 20,000 workpeople are now employed.

In view of the leading position in apprentice training held by the company, largely due to the pioneer work of Sir Arthur Fleming, this note cannot properly end without reference to the visit paid to the apprentice training school. The quality of the work being turned out and steady application of the hundreds of boys to their varied tasks was most heartening.

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New Columbite Discoveries

There have recently been some important discoveries of new sources of columbium. In Canada the Dominion Gulf Company reports a very large deposit about 150 miles north-west of Sudbury, Ontario, while in Uganda a new company, Sukulu Mines Limited has been formed to develop large deposites of phosphates and columbite with a capacity up to 1 million tons of columbium pentoxide per annum. Hitherto, world production of columbite has been derived largely from the tin-columbite ores of Nigeria.

These new discoveries have been announced at a time when the price of columbite has been more than halved owing to the cessation of purchases by the U.S. Defence Materials Procurement Agency which, in .1952, announced the payment of a 100 per cent. bonus in order to build up the U.S. strategic stockpile. Not unnaturally such a large increase in price considerably stimulated world production and at the same time reduced normal commercial purchases. About a year ago it was announced that the target figure for the U.S. stockpile had been achieved and that the special bonus would cease. Following this a number of Nigerian producers were forced to reduce production and some of the smaller mines closed down. It appears that an attempt is now being made by the larger producers to prevent the price falling below 200*s.* per unit, equivalent to £700 per ton for ore containing 70 per cent. combined pentoxides, for which the U.S. buying price was over £2,000 per ton in 1954. The objects of this attempt at stabilisation are stated to be to prevent loss of further production capacity and to encourage consumption.

At the present time the main use for columbite is in the production of ferro-columbium for addition to high-chromium steels to prevent loss of carbon in welding, for the prevention of intergranular corrosion and in the production of welding rods. In addition heat resisting steels containing columbium are required for certain applications in gas-turbine engines while columbium itself is one of the nuclear elements for atomic breeder reactors. It is as yet too soon to say when the present over production of columbite will cease and the further development of new deposits become necessary. The history of the last four years in this field provides an object lesson in the dislocation which may be caused to primary producers by short-term Government planning decisions unless some thought is given to their longer-term implications.

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Textiles into Engineering

When the first man-made fibres became available on a commercial scale some 30 or 40 years ago, a significant step was taken in the substitution of chemical engineering for traditional textile techniques. Progress in this direction since those days has been uneven but the trend has been clear enough and it has become increasingly marked in recent years. The chairman's statement of Courtaulds, Limited, for the year ended March 31, 1956, underlines this technical change. The total world production of man-made fibres in 1955 was 5,600 million lb. Within this total the output of synthetic fibres increased over the year by one-fifth while four-fifths was in viscose and acetate continuous-filament yarn and staple. Nevertheless, the proportion of total output accounted for by synthetics is increasing, being about 10 per cent. in 1955 compared with 8 per cent. in 1954. As with natural fibres, competition is keen in export markets but with an engineering tradition of high capital investment and multiple-shift working in this industry the United Kingdom is in a much stronger position to compete even against Japan than it is in, say, cotton yarn. Sir John Hanbury-Williams had to report a fall in the group's trading and investment income in the latest financial year and he was guarded in his views on the immediate future of the textile market. He was able to say, however, that the reduced net income was due to a large extent to rising costs and a policy of holding their prices down and the flavour of his remarks suggested both confidence and a willingness to accept competition.

There are other signs that textile techniques may be challenged to an increasing extent. The Bradford Dyers Association, Limited, has taken a financial interest in a new company called Bondina (B.D.A. Limited) which is to make non-woven fabrics under licensed patents. A plant has been put up near Halifax and it is expected that before the end of 1956 production will begin on these fabrics which will be made of fibres bonded by chemical and physical means without using spindles and looms.

Developments of this kind, if successful, are of course double edged. They may provide fresh impetus by substituting an engineering approach for a textile tradition but they mean that the textile-machinery industry must move even further into the field of machinery manufacture for man-made fibres. Fortunately, some concerns have already started to move in this direction and not a few are already basing their prosperity on the adaptation of machines to the manufacture of the new fibres. Such a change-over, however, is comparatively small compared with the effect of the demand for the textile-machinery makers' traditional products if spindles and looms were ever to be replaced by other machinery on a really significant scale.

CRUSHING AND MIXING UNDER CONTROLLED CONDITIONS

A NEW PRINCIPLE THEORETICALLY DEVELOPED

By Dr. M. S. Frenkel

This article describes a simple fundamental principle which meets all the requirements of a continuous crusher for various materials. It gives complete uniformity of crushing effects on all elements of the throughput, combined with uniform intermixing. Different kinds of crushing effect occur in the same machine, the proportions of each being controlled to suit materials of different properties. Crushing from large lumps to fine powder is possible in the same machine. The construction of a crusher on this principle is such as to avoid excessive and fluctuating loads on bearings, to provide for minimum wear, and to allow the components to be adjusted very simply to compensate for wear. It is also possible to combine in one machine more than one variant of the basic principle and thus to crush materials of different properties independently and then combine them in a final milling and intermixing cycle.

In principle the machine consists of two relatively-rotating co-axial components with an annular space between them, and having operating surfaces of a certain complementary configuration. The material is continuously crushed and transported axially between these components. The principle is a development of a continuous mixer* designed by the writer.

Mechanical Requirements for Crushing

Mechanically the requirements for crushing are:

1. The lumps of material should be gripped continuously between components which exert on them forces in three mutually perpendicular directions with impact. The components should at the same time have corresponding relative velocities in three mutually perpendicular directions. This is to produce continuously three beam actions on the lumps to split, shear and break them up, and to separate the fragments from each other. The impacts should take place all over the surface of a lump, in order to hit the weak spots, and the process should continue until the required fineness of grain is achieved.
2. The material should be given such motions that a large part of the total crushing action will take place between the lumps themselves.
3. Every part of the operative surface enclosing the material should simultaneously exert the above crushing effects, and the entire space within the crusher should be used for the crushing operation.
4. The crushing effects should not be at random, but in a definite order, ensuring uniformity of treatment of the material.
5. The actual crushing forces should, as far as possible, cancel within the machine, so putting the minimum load on the bearings. Reciprocating loads in particular should be avoided.

Constructional Features

1. The operative surfaces of the two principal components (1 and 2, Fig. 1), are designed as screw threads (12 and 13), having relative rotations, preferably opposite.
2. The cross-sectional area of the groove 15 is reduced continuously from maximum to zero in the direction of transport of the material along the annular space. Material is thus continuously extruded from the groove to be crushed with the aid of the outer screw 2.
3. The groove 16 of the outer screw is complementary in cross-section, that is, its cross-sectional area develops from zero to maximum as that of the inner screw develops from maximum to zero. Provision is thus made for the increasing amount of material extruded from groove 15 to be gripped and taken up by groove 16. This complementary development of the two screws is seen in screw-section 7 in Fig. 1.
4. The clearance 18 between the lands of the two screws is as small as is required to ensure that material protruding from the inner screw is gripped immediately and worked by the outer screw. The construction gives a continuously conical interface 14 betwen the two components. Manufacture of the components to close limits is unnecessary; they could, for example, be used in the " as-cast " condition. Initial setting of the two components is by axial adjustment of the inner one. Wear can be taken up in the same way, and clearance adjusted to various requirements.
5. To ensure that the material transferred from the inner to the outer screw is also transported towards the exit, the outer screw, with its opposite rotation, must have a thread of opposite hand to that of the inner screw.
6. In order that lumps of material protruding from the inner groove should be met with impact by the thread 13 of the outer screw, the threads should cross at a considerable angle. This requirement is met by the fact that they are of opposite hand.

* Frenkel, M. S. *The Chemical Age*, June 25, 1955. " Enforced order mixer, adjustable extruder, multi-mixer and dynamic gland."

Crushing Effects Due to Material Transfer

On transfer from the inner to the outer groove the material passes from one path leading to the exit to another which crosses it. This involves a sudden change of direction, and by impact and rotation of the lumps leads to crushing effects both by the screws and by lumps against other lumps. In screw-section 8, in which the return material-transfer takes place, material passing from the outer back to the inner screw, the same crushing effects occur, producing complete equalisation of crushing over the two screw-sections.

Crushing Effects in Transition Zone

1. Owing to the opposite rotation of the screws the bottom of the inner groove 15 and the land of the outer screw 13 continuously approach each other radially, as shown diagrammatically by the two distances 19a and 19b in Fig. 1. This produces radial indentations 17 of the land 13 into the material.
2. The radial indentation extends along the land 13, producing a crushing force in that direction.
3. As the land 13 sweeps across the width of the groove 15 against the material being extruded from it, a crushing force perpendicular to the pushing flank of the thread is exerted.
4. The material is thus subjected to crushing forces producing beam-actions in three mutually perpendicular directions (radial to the screw-axis, along the land 13, and perpendicular to the pushing-flank). These give rise to radial indenting, shearing and splitting of the lumps and separation of the fragments.
5. These crushing effects are accompanied by rotation of the material about three mutually perpendicular axes:

(*a*) About an axis parallel with the shaft-axis, owing to the opposite rotations of the male and female screws.

(*b*) About axes radial to the screw-axis, owing to the opposite rotations of an outer land 13 and an inner land 12 gripping the material between them.

(*c*) About the axis perpendicular to these two axes, that is, in each plane containing the screw-axis, owing mainly to the relative radial motion in this plane of the outer land 13 and the inner groove 15. These rotations occur over the whole width of each groove, as the land sweeps across it.

Owing to these rotations, every element of the surface of each lump is treated, which ensures hitting the weak spots for splitting.

Crushing Effects in " Giver " Grooves

The couples about three mutually perpendicular axes in the transition zone producing the

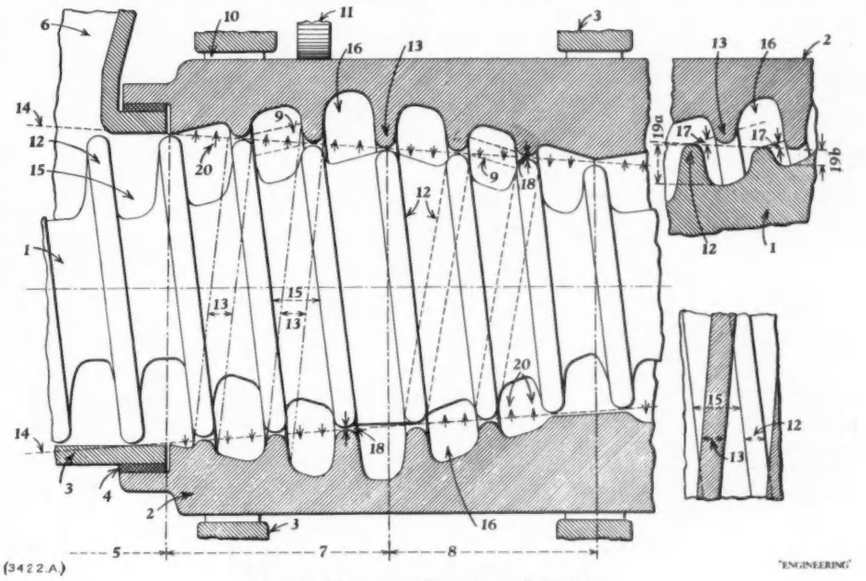

Fig. 1 Diagrammatic section of crusher.

1. Inner screw.
2. Outer screw.
3. Fixture.
4. Gland.
5. Feed-section of inner screw.
6. Entry funnel.
7. Outwards material-transfer section.
8. Inwards material-transfer section.
9. Transition zone between screws.
10. Bearing for outer screw.
11. Drive for outer screw.
12. Helical thread of inner screw.
13. Helical thread of outer screw (opposite hand to 12).
14. Conical interface between screws.
15. Groove of inner screw.
16. Groove of outer screw.
17. Indentations of thread 13 into material in groove 15.
18. Clearance between opposite lands of screws.
19. Indication of approach of land to groove.
20. Arrows showing direction of material transfer.

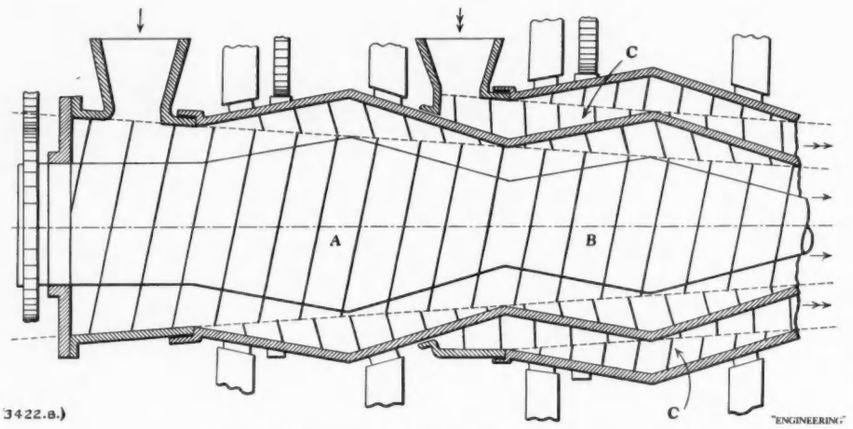

Fig. 2 Adaptation of principle as a multi-crusher.

rotations there also produce, by effects depending on the properties of the material, rotations about three mutually perpendicular axes in the "giver" groove. Beyond these three couples there act in the "giver" groove three other couples about three mutually perpendicular axes:

1. In the relative motion of the lumps in the groove the friction between them and the pushing flank of the groove produces a rotation of the lumps about axes radial to the shaft axis.
2. The lumps rotate about the shaft axis.
3. These two rotations of the lumps give rise to a gyroscopic couple about the axis perpendicular to these two axes and hence normal to the respective planes containing the shaft axis, producing rotations in these planes. The magnitude of the rotation produced by the gyroscopic couple depends on the properties of the material.

The gyroscopic couples differ in magnitude as a function of distance from the pushing flank, since the friction forces between a particular lump and the layers of lumps between it and the pushing flank, as well as its rotation about the shaft axis, are functions of this distance from the pushing flank. The magnitudes of the rotations about these axes change as a function of time on account of gyroscopic effects and thus manifest as an oscillation, depending on the properties of the material. These rotations lead to important crushing and milling effects between the lumps themselves in the groove, which increase with the rotational speed of the groove. They can thus be regulated.

Crushing Effects in the "Taker" Grooves

Beyond the crushing and milling effects described, there are in the "taker" grooves continual and considerable impulses caused by the transfer of fragments of lumps from the transition zone, where they have been given certain motions and rotations, into the "taker" groove. Here the lumps have different motions and oscillating rotations, and further crushing and milling between the lumps themselves occurs.

Equalisation of Particle-Treatment

The crushing effects in screw-section 7 are equalised by the complementary crushing effects in the following screw-section 8, thus providing uniformity of all effects. This can be explained by considering an individual fragment.

If n represents the number of turns of each screw forming the "giver" and "taker" grooves between them in section 7, then at the end of that section a fragment which has been transferred at a turn m some way along the section has undergone m turns of crushing effect in the "giver" groove and $(n\text{-}m)$ turns of different effect in the "taker" groove. The total crushing effect on this fragment is different from that on fragments transferred at other axial positions.

However, in section 8 the fragment undergoes $(n\text{-}m)$ turns of "giver" groove crushing in the outer screw and m turns of "taker" groove crushing in the inner screw. Thus, over the two sections the fragment receives n turns of "giver" groove crushing and n turns of "taker" groove crushing, apart from the crushing in the transition zones, which affects all fragments uniformly. Hence the complete cycle provides, in "enforced-order," complete uniformity of crushing, milling and mixing. No particle can escape.

These distinguishing features are provided by a unit consisting of components which are complementary in pairs on the principle of the potential of "convergence-divergence" developed by the author, which is specifically treated elsewhere* with examples in various fields.

For example, one feature of convergence is that each of the two screws has a section of "giver" grooves and a section of "taker" grooves, and one feature of divergence is that the sequence of sections of "giver" and of "taker" grooves is reversed for both screws. Thereby the construction provides the potential of "convergence-divergence" which brings about self-governing equalising processes. The potential of "convergence-divergence" manifests effects according to the properties of the material at the respective axial positions, giving, for example, crushing for lumps, mixing for powders, etc. This, with the self-governing equalising processes, leads to uniformity with inherent stability at outlet*.

The basic mixer-crusher construction further provides the foundation for independent adjustability of effects along the axis, by means of independent adjustability of rotational speeds of sections of the outer screw. The inherent stability of output quality is maintained through adjustability of the clearance.

Some Resultant Features

1. The properties of the crusher are such that comminution can be brought from any size to any required degree of fineness and uniformity by the use of two or more complete cycles in a single machine.
2. By adjustment of the speeds of rotation of the screws in an operative machine, and originally by the design of the threads, the proportions of the crushing effects in the transition zones and in the grooves can be varied to suit the properties of different materials and the requirements of minimum wear. As stated earlier, axial adjustment of the inner screw enables wear to be taken up easily.
3. All reciprocating effects which are destructive to bearings are eliminated, and a large part of the crushing forces is balanced within the system. The remaining load on the bearings could largely be cancelled by constructing two units in tandem with the corresponding parts connected accordingly.

Adaptation as a Multi-Crusher

Fig. 2 indicates diagrammatically a multi-crusher in which the inner unit, consisting of cycles A and B in series, and in the outer unit C materials of different properties can be crushed independently, each under the required conditions provided by the independently adjustable rotational speeds of the components. The crushed materials could then be combined in a final common milling and intermixing cycle, which is not shown in the drawing. In this design each component except the innermost and the outermost ones serves two crushing cycles, so that for n units designed co-axially in parallel there are only $(n + 1)$ rotatable components instead of $2n$. There is thus a saving on driving mechanism and floor space. Furthermore, such multi-unit crushers could be designed with opposite directions of material transport, to cancel axial reactions within the bearings.

* *loc. cit.* previous column.

* Frenkel, M. S., *British Plastics*, May, 1956, "The Principle of the Potential 'Convergence-Divergence' as Foundation for Research in Various Fields." *Proc. I. Mech.E.*, 1955, Vol. 169, No. 36, page 736. *Water Power*, March, 1956, page 115, "New Principle in Design of Sealing Glands."

HEAT RATE TESTS ON TURBO-ALTERNATORS

EFFECT OF VARYING THE EXHAUST PRESSURE

By G. Woodhead, ASSOC.M.C.T., G.I.MECH.E.*

The absolute pressure recorded at the exhaust of a turbo-alternator is dependent on such variables as the load and the inlet temperature of the circulating water. It is also dependent on the quantity of circulating water entering the condenser, and the cleanliness and any air leakage into the condenser. Changes in these variables can considerably affect the performance of the machine and careful control, based on economic considerations, can result in a substantial saving in operating costs.

If the quantity of circulating water is increased it may produce an exhaust pressure which results in better heat rate being obtained. This may, however, necessitate the use of additional circulating pumps and an increase in the auxiliary power consumption which may offset any gain due to the improvement in exhaust pressure. This is shown by the results of a number of short duration tests which were carried out at Carrington power station in the North Western, Merseyside and North Wales Division of the Central Electricity Authority to obtain performance data at low turbine exhaust pressures.

The present equipment of this station consists of two 60 MW hydrogen-cooled turbo-alternators

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TABLE I.—*Absolute Exhaust Pressures at Carrington.*

Month	Monthly average turbine exhaust absolute pressure in inches of Hg.
October, 1954	0·90
November, 1954	0·80
December, 1954	0·72
January, 1955	0·64
February, 1955	0·76
March, 1955	0·86

TABLE II.—HEAT RATE TESTS WITH VARYING TURBINE EXHAUST PRESSURES ON CARRINGTON NO. 1 TURBO-ALTERNATOR.

	Nos. 4 and 5 high-pressure heaters by-passed				All heaters in service								
Test No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal load per cent. of max. continuous rating	100	100	100	100	100	100	100	100	100	100	Maximum output	100	Maximum output
Stop valve pressure lb. per sq. in	895	902	906	902	888	890	901	886	889	915	915	923	911
Stop valve temperature deg. F.	906	900	894	890	902	897	897	897	897	901	901	900	895
Final feed water temperature, deg. F.	250	250	250	250	381	379	379	379	379	378	384	378	385
Turbine exhaust abs. pressure in. Hg.	0·58	0·66	0·79	0·87	0·59	0·69	0·86	1·0	1·15	1·36	1·10	0·63	0·675
Net condensate lbs. per hour	463,577	468,079	471,689	471,377	508,010	507,890	508,490	508,780	506,610	508,333	541,542	501,276	545,305
Net output kWh	59,993	60,243	60,280	59,799	60,974	60,777	60,356	60,408	59,909	60,619	65,019	60,719	66,419
Steam rate as run lb. per kWh.	7·7272	7·7698	7·8250	7·8827	8·3316	8·3566	8·4248	8·4224	8·4563	8·3857	8·3290	8·2557	8·2101
Heat rate as run, B.Th.U. per kWh.	—	—	—	—	—	—	—	—	—	—	9,104	—	8,941
Corrected heat rate B.Th.U. per kWh.	9,556	9,576	9,605	9,652	9,137	9,160	9,238	9,226	9,262	9,226	—	9,090	—

Tests No. 1 to 9—Condensate measured by orifice plate in feed water pipeline to deaerator.
Tests No. 10 to 13—Condensate measured by Venturi in feed water pipeline after No. 5 heater.

of Metropolitan-Vickers manufacture, which are supplied with steam at a pressure of 900 lb. per square inch and a temperature of 900 deg. F., the pressure at the exhaust being 1·4 in. of mercury absolute and the feed-water temperature 380 deg. F. Exhaust steam from the turbines is cooled in twin condensers. The circulating water is drawn from the Manchester Ship Canal by four pumps which discharge to a common inlet, the amount supplied to each condenser being regulated by the discharge valves. It was found that with the specified quantity of circulating water the absolute pressure at the turbine exhaust during the winter months approached 0·6 in. Hg, as shown in Table I; and the purpose of the additional tests was to determine if the utilisation of these low exhaust pressures was economically justified.

ARRANGEMENT OF TEST EQUIPMENT

The tests were carried out using the equipment which had already been installed for the official acceptance trials. The condensate flow was calculated from the pressure drop across a sharp-edged orifice plate, which was located between two straight lengths of accurately-bored pipe. This pipe was inserted in a straight length of condensate piping to the deaerator heater after the junction with the line from the drain pump. Thus the flow measured was the total steam to the turbine plus the steam to the ejectors and the water to the gland paddle wheels, less the steam to the deaerator. The pressure tappings were corner taps in the piezometer rings, which were incorporated in special flanges adjacent to the orifice plate; and venting cocks were fitted to enable the entrained air to be released. The pressure difference across the orifice plate was measured by duplicate single-leg mercury manometers.

Steam to the ejectors was calculated from the nozzle diameters assuming critical flow; and the water to the turbine paddle glands was measured by a Kent rotary flowmeter. The steam flow to the deaerator heater was calculated from pressure and temperature readings taken at the steam inlet to the deaerator and the temperature rise of the condensate through the heater. Changes in the level of water in the deaerator storage tank were recorded, and the flow to the high pressure heaters was corrected accordingly.

All steam pressures above 15 lb. per square inch were measured prior to the tests by Bourdon tube gauges which were mounted on a temporary panel on the turbine floor. Short lengths of connecting piping were used to avoid errors due to unbalanced water columns.

The turbine exhaust pressure was taken as the average reading of four mercury columns connected to tapping points close to the exhaust flange on each side of each half of the condenser. At fifteen minute intervals each U-tube was disconnected to permit any water which might have accumulated in the piping to be drawn into the condenser.

All steam and condensate temperatures were measured by National Physical Laboratory-calibrated Advance (T1v) thermocouples, the cold junctions of which were maintained at 32 deg. F. by immersion in melting ice. The ambient air temperatures of the mercury columns and the two flow manometers were taken by calibrated mercury-in-glass thermometers.

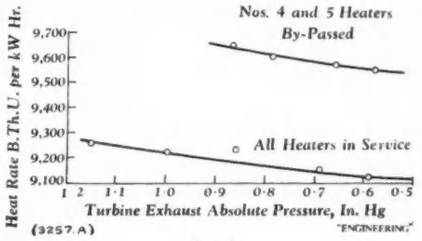

Fig. 1

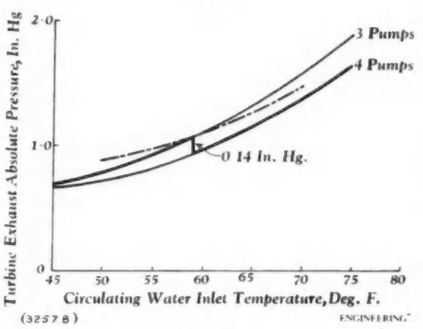

Fig. 2

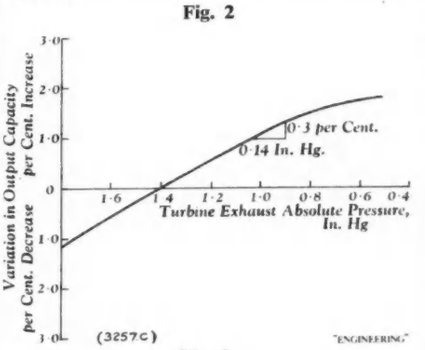

Fig. 3

Figs. 1, 2 and 3 Increased output of turbo-alternators can be obtained by lowering the exhaust pressure of the turbine and this pressure is dependent on several factors. Lowering the pressure economically depends on the cost of effecting the reduction and the relationships with three factors are illustrated above for a 60 MW set at Carrington Power Station.

ALTERNATOR OUTPUT

The alternator output was measured by the two-wattmeter method, using duplicate single-phase watthour integrating meters with associated voltage and current transformers. The assembly was calibrated prior to the tests together with the voltmeter and ammeters which were used to determine the power factor. The power consumption of the auxiliaries associated with the alternator hydrogen-cooling system was calculated from ammeter readings and deducted from the alternator output.

It was verified before the tests commenced that all necessary isolation had been carried out and that the machine was operating according to the specified cycle. All readings were taken at five-minute intervals, the exception being the flow manometer readings which were taken at half-minute intervals.

TEST RESULTS

Tests Nos. 1 to 4 in Table II shows the heat rates for the machine with Nos. 4 and 5 high pressure heaters by-passed to allow modifications to be made by the heater valves. This was not considered detrimental to the objects of the test insofar as the increased steam flow to the condenser, and hence the increased exhaust loss, would merely emphasise the expected worsening of the heat rate at very low exhaust pressures. It will be seen, however, that the heat rate was progressively better down to an absolute exhaust pressure of 0·58 in. Hg. The results of these tests, together with subsequent tests which were carried out with all heaters in service and numbered 5 to 9 in Table II, are plotted in Fig. 1. From this it is evident that the latter tests merely confirmed the results of the previous tests, and no turning point in the heat rate curves was reached.

There appeared to be some justification for reducing the number of pumps supplying circulating water to the condenser during winter months and observations, which were made of the variation in pressures recorded at the turbine exhaust of the two machines with first three and then four circulating pumps in operation and various circulating water inlet temperatures, are shown in Fig. 2.

Each circulating water pump has a power consumption equivalent to 0·3 per cent. of the combined output capacity of the two turbo-alternators and therefore the use of an additional pump requires a resultant improvement in turbine exhaust pressure sufficient to increase the output capacity of the machine above this figure.

The improvements in turbine exhaust pressure, which were necessary to produce this increase in output capacity, were determined from Fig. 3 and plotted on Fig. 2 in order to establish the exhaust pressure at which the changeover from four-pump to three-pump operation should be effected. From these curves it was apparent that, during the winter months with low circulating water inlet temperatures and an exhaust pressure below 0·9 in. Hg., the employment of the full pumping capacity was not economically justified with the turbo-alternators operating at full output capacity.

Tests conducted during the early part of 1955 on a boiler feed pump necessitated the insertion of a calibrated test Venturi tube in the final feed pipeline to the boilers. Advantage was taken of this opportunity to carry out further heat rate tests on the machine to determine if any deterioration in turbine performance had taken place. The station electricity meters, which had been calibrated against the manufacturer's test instruments were used to measure the alternator output and calibrated chromel-alumel thermocouples were used for the temperature measurements. No estimation of the steam flow to the

deaerator was necessary as this quantity was included in the condensate measured by the Venturi meter. The deduction of the ejector steam and gland water quantities established the total steam to the turbine.

MAXIMUM OUTPUT TESTS

The corrected heat rate at maximum continuous rating determined by Test No. 10 with this arrangement was within 0·7 per cent. of the official acceptance test figure for the machine. This was considered to be in reasonable agreement and indicated no deterioration in the performance of the machine. A maximum output test as shown in Test No. 11 was next undertaken to determine the loads which could be carried by the machine in an emergency. The output obtained during this test was limited by the state of the condenser, but it will be seen that a substantial improvement in the heat rate was achieved. The turbovisory panel instruments were under strict observation during the test period and no abnormal indications were apparent.

Routine condenser cleaning was carried out during the week-end and the resultant improvement in the exhaust pressure was utilised to determine the heat rate at maximum continuous rating for the machine at a low exhaust pressure, as shown in Test No. 12. It will be seen that the figure realised is also approximately 0·7 per cent. better than the comparative tests carried out during the previous year, although the improvement in heat rate against decrease in exhaust pressure is of the same order as the previous test.

With this improvement in condenser performance a further maximum output test was initiated. The combination of high output and low exhaust pressure resulted in an exceptionally low heat rate being attained, as shown in Test No. 13. An interesting phenomenon was observed throughout all these trials, namely that the temperature of the condensate leaving the condenser was up to 5 deg. F. higher than the temperature equivalent to the turbine exhaust absolute pressure as represented by the average of the four mercury manometer readings.

If it is considered that these exhaust pressure readings do not present a true average exhaust pressure and that the true figure is one suggested by the condensate temperature, it follows that the machine should be credited with a better performance.

With low exhaust pressures, however, the velocity of the steam entering and sweeping the periphery of the central flow type condensers may be in the region of 1,000 to 1,200 ft. per second. If the kinetic energy of this high velocity steam could be converted into pressure energy before condensation then the consequent rise of pressure would correspond to an increase in condensing temperature of as much as 12 deg. F. It may be that a small proportion of the velocity head is converted by diffusion to pressure, and that at low exhaust pressures this is sufficient to increase the condensate temperature by a significant amount. This may in part account for the high output possible and for heat rates as low as 8,941 B.Th.U. per kWh. which have been recorded on this turbo-alternator under favourable conditions.

The author wishes to thank Mr. A. R. Cooper, Controller, North West, Merseyside and North Wales Division of the Central Electricity Authority, for permission to publish this article.

CRYSTAL LATTICES AND THEIR IMPERFECTIONS

DIRECT STUDY BY ELECTRON MICROSCOPE

Soon after the discovery of X-rays, it was found that a crystal placed in the path of an X-ray beam will divide it into a number of "reflected" beams, the intensisites and directions of which vary from one substance to another. Measurements on these reflected beams indicate that the atoms of which the crystal is built are arranged in a highly regular three-dimensional lattice, the distance between the atoms being between 10^{-7} and 10^{-8} cm. (10^{-7} cm. equals 1/10,000,000th cm.).

This distance is so small that it is impossible to see the individual atoms or molecules in an optical microscope, since this will allow the viewer only to see details of dimensions of about 10^{-4} cm. or slightly less, at a magnification of perhaps 2,000 times. In order to resolve smaller details, it is necessary to turn to the electron microscope. One of the latest models of this instrument developed by Professor Ruska, the original inventor, gives the possibility of obtaining photographs of crystals at a magnification of 1,500,000 showing details of dimensions smaller than 10^{-7} cm.

Using one of these microsopes at the Tube Investments Research Laboratories, Hinxton Hall, Cambridge, Dr. J. W. Menter has succeeded in imaging directly the lattice of a crystal in which planes of molecules are spaced 10^{-7} cm. apart. The distance between them, measured directly from the photographs, agrees closely with the value previously deduced by the indirect methods of X-ray diffraction.

The materials photographed are copper and platinum phthalocyanine, the molecules of which consist of a ring of organic material surrounding a central metal atom (copper phthalocyanine is the well-known blue paint pigment, monastral blue). Very thin crystals of these materials have been prepared and examined by directing the electron beam of the microscope through them. Under these conditions, in the orientation chosen, a particular set of crystal planes separated by $1{\cdot}0 \times 10^{-7}$ cm. in copper phthalocyanine and $1{\cdot}2 \times 10^{-7}$ cm. in platinum phthalocyanine are seen edge on.

The accompanying microphotograph, Fig. 1, shows a platinum phthalocyanine crystal obtained in this way, at a magnification of 1,500,000. Ideally, the image of the crystal lattice viewed in this orientation should consist of a rectangular array of dots, but this is not obtained because the spacing of the molecules along the lines in the photograph is too small to be distinguished even with this microscope. In some other crystals, where the distance between the planes of molecules in two directions is within the resolution limit of the microscope, arrays of dots have been seen.

This demonstration, that it is now possible to obtain a direct image of a crystal lattice, opens up entirely new vistas for the study of the properties of solids.

More than twenty years ago it was shown by Sir Geoffrey Taylor that the comparative weakness of crystals was explicable on the assumption of a limited number of imperfections of a particular type called dislocations, in an otherwise perfect crystal lattice. Hitherto evidence for their existence had been very indirect, but already this new method of studying crystal lattices has shown that these imperfections may be photographed directly.

The microphotograph, Fig. 2, shows a dislocation in a platinum phthalocyanine crystal, also at a magnification of 1,500,000. Fig. 3, showing the nature of the dislocation more clearly has been copied from the microphotograph.

The dislocation is formed where one of the planes of molecules terminates inside the crystal, and its immediate neighbours continue to grow and join up again so that the spacing of the crystal planes at some distance from the dislocation is uniform. Near the dislocation, however, the lattice is considerably strained since the regular lattice structure is disturbed, exactly as had been suggested in Taylor's theory.

One of the main objects of contemporary research into the properties of solids is to try to understand the plastic, strength, fracture, fatigue, and creep properties in terms of the movement of imperfections of the type illustrated.

Now that it is possible to see these imperfections directly, it should be possible to study their movement under stress by a recording cinematograph camera.

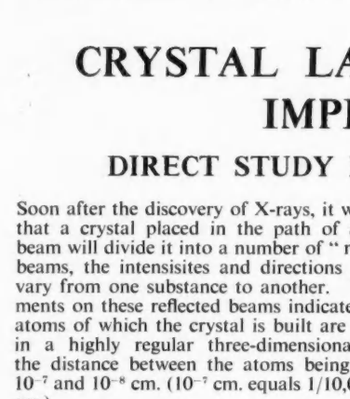

Fig. 1 (Left) Part of crystal of platimun phthalocyanine showing planes of molecules $1{\cdot}2 \times 10^{-7}$ cm. apart. × 1,500,000.

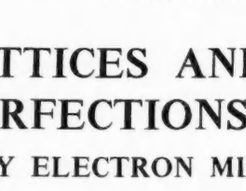

Fig. 2 Part of a crystal of platinum phthalocyanine showing an imperfection in the structure. × 1,500,000.

Fig. 3 Copy of the microphotograph shown in Fig. 2, indicating the exact position of the imperfection.

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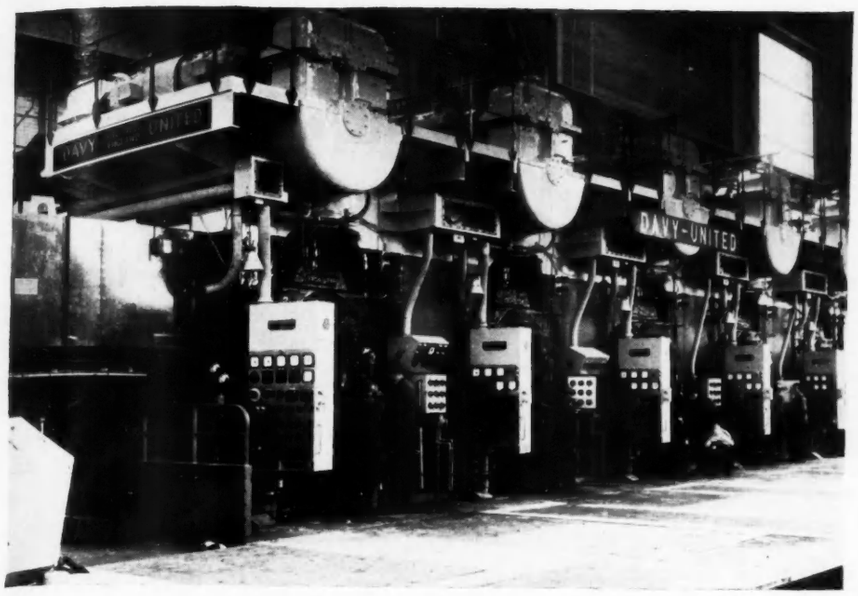
OFFSHORE BORING FOR COAL

Films and "stills" showing the building and launching in the Firth of Forth, near Kirkcaldy, of the National Coal Board's sea boring unit were displayed at the St. Ermins Hotel, London, S.W., on June 13 and gave an excellent idea of the design of the structure and of the difficulties encountered during its erection.

As described in detail in ENGINEERING on May 27, 1955 (vol. 179, page 674), this boring unit consists of a tubular steel tower, which is mounted on a cruciform base formed from two box girders, and carries boring and accommodation decks at the top. The overall height to the top of the drilling rig is 184 ft. and its total weight is 490 tons. The drilling rig, which is 54 ft. high, is driven by a Diesel engine and the drill itself is guided to the river bed by a tubular casing of flanged sections, 145 ft. long and 24 in. in diameter. The operating power and the lighting is supplied from three Diesel-electric generators which are connected to a three-wire distribution system.

The consulting engineers for this installation were Maunsell, Posford and Pavry, Victoria-street, London, S.W.1, while the main contractors were the Cleveland Bridge and Engineering Company, Limited, Darlington.



Making final adjustments to the four-high five-stand cold-reduction rolling mill at the new Velindre Works. The mill will cold-roll strip at speeds of up to 5,000 ft. per minute for subsequent processing into tin-plate. The photograph is taken from the exit end of the mill.

STEEL CO. OF WALES EXTEND THEIR WORKS

FIRST CONTINUOUS ANNEALING PLANT IN EUROPE

On May 1, 1947, the Steel Company of Wales Limited was incorporated following an amalgamation of a number of the South Wales interests of the Guest Keen Baldwins Iron and Steel Company, Limited; Richard Thomas and Baldwins, Limited; John Lysaght, Limited, and the Llanelly Associated Tinplate Companies, Limited. The three main producing units of the company are the steel, tin-plate and Newport divisions. The first comprises the Port Talbot and the adjoining Margam and Abbey Steelworks, and the Cornelly limestone quarry some six mines from Port Talbot. The tin-plate division consists of the Trostre cold reduction plant near Llanelly, hand mills situated near Llanelly and Swansea and at Melingriffith, near Cardiff, and Lydney in Gloucestershire, and the Velindre plant, now under construction, five miles north of Swansea. The Newport division comprises the Orb Works, near Newport, which, it is stated, supplies over 50 per cent. of the consumption of steel sheets for electrical machines in the United Kingdom.

Since 1947 the Margam Works have been completely modernised and extended, the Abbey works have been built on a site which formerly consisted of sandhills and marshland, and the Trostre tin-plate plant has been completed. Work on the main programme of construction of the new cold-reduction tin-plate plant at Velindre commenced in August, 1953. Several years before this, however, there had been a certain amount of preliminary site clearance before the decision was made to erect the first cold-reduction tin-plate plant at Trostre.

VELINDRE COLD-REDUCTION TIN-PLATE PLANT

The main programme of plant erection at Velindre commenced in the autumn of 1955 and since that time much of the equipment, which has a value of more than £11,500,000, has been installed. This comprises a five-stand cold-reduction rolling mill, one electrolytic strip cleaning line, three portable batch-annealing furnaces and seven furnace bases, one tomper rolling mill and one shear line. At the time of our visit to these works, on June 26, all this equipment was being prepared for commissioning. The plant still under erection at Velindre includes one cleaning line, four portable batch-annealing furnaces and seven furnace bases, one continuous annealing plant, one temper rolling mill, two shear lines, two coil preparatory lines and three electrolytic tinning lines (of which only the foundations have been put in at present). It is estimated that the Velindre Works will reach full production by the end of 1958.

Hot-rolled pickled coils from the continuous steel-strip rolling mill and continuous pickling line at Abbey Works are to be conveyed by rail for cold rolling into tin-plate gauges at Velindre, some 18 to 19 miles distant, on specially-designed railway wagons. Road haulage can also be used when required. The maximum weight of a coil is 36,000 lb., this resulting from the welding together of single coils at the pickling line. The maximum gauge and width for cold-rolling are 0·108 in. and 38 in., respectively.

The four-high five-stand tandem cold-reduction rolling mill, shown in the accompanying illustration, is equipped with work rolls 21 in. in diameter and backing-up rolls 53 in. in diameter. All rolls have a body length of 42 in., and the maximum speed of the mill is 5,000 ft. per minute. The work rolls have tapered roller bearings and the backing-up rolls, Morgoil bearings. The rolls are cooled by means of water sprays and a mixture of palm oil and water is sprayed on to the strip to lubricate the roll faces.

The horse-power of the main direct-current driving motors for the No. 1 stand of the mill is 1,750, for the Nos. 2 and 3 stands, it is 3,500, for the No. 4 stand, 4,000, and for the No. 5 stand, 5,500. The coiling reel at the exit end is driven by a 900 h.p. motor. The driving motors and motor-generator sets are housed in an air-conditioned motor room adjacent to the mill building.

The coils on the exit reel have a maximum outside diameter of 72 in., and can be either cleaned in the electrolytic cleaning lines and then batch annealed before passing on to the temper rolling mills, or they can be continuously annealed and then passed on to the temper mills. Until the continuous annealing line is completed the former method will be used and the coils will be taken by tractor to the adjacent cleaning bay.

ELECTROLYTIC CLEANING LINE

After cold rolling, all traces of rolling oil must be removed from the strip prior to annealing. In the electrolytic cleaning line it is first passed through a 17 ft. 6 in. long caustic dip washer tank which removes the bulk of the palm oil. After passing through a scrubber unit the strip then enters the electrolytic cleaning tank which removes all remaining traces of palm oil.

After passing through a second scrubber unit the cleaned strip is finally passed through a hot-water spray rinse tank, 25 ft. long, and emerges through wringer rollers before entering the hot-air drying sections. Finally the strip is passed through the tension roll unit before being re-wound in coils 54 in. in diameter ready for annealing. These coils weigh approximately 17,000 lb.

The maximum speed of operation of the cleaning line is 2,500 ft. per minute.

After cleaning, the coils are conveyed by fork-lift truck to the batch-annealing department where they are placed on furnace bases, there being two rows of four stacks on one base. Each stack is four coils high. The coils are separated by ribbed convector plates and the total charge on each base is about 250 tons. A special heat-resisting steel cylindrical hood is placed over each stack, the bottom being made gas-tight by means of a sand seal. A portable furnace is then placed over the base. The furnace consists of a reinforced steel refractory-lined casing fitted with 38 gas burners, the temperature is continually recorded and automatically controlled. To prevent the oxidation of the steel coils a neutral gas mixture is circulated in the inner covers by means of centrifugal fans.

CONTINUOUS-ANNEALING PLANT

The alternative to electrolytic cleaning and batch annealing is continuous annealing, and the continuous annealing plant now being installed at Velindre is stated to be the first of its kind in Europe. It can anneal strip 38 in. wide and of normal tin-plate gauges at a speed of about 600 ft. per minute. Thus a coil of 30,000 lb. takes approximately an hour.

The strip from the cold-reduction rolling mill passes through a vertical cleaning unit which removes all traces of rolling oil and dries the metal before it passes through a looping tower prior to entering the furnace. The strip then makes five heating, two soaking, three slow cooling, 16 fast cooling and two final cooling passes before it emerges from the furnace section of the line and thence through a second looping tower before being recoiled. During the heating, soaking and cooling cycle inert gas is circulated inside the furnace section to prevent oxidation of the strip.

The whole line is approximately 210 ft. long by 53 ft. high.

Following annealing, the strip is cold rolled to the required temper in one of two four-high two-stand tandem temper rolling mills capable of operating at a maximum speed of 4,000 ft. per minute. The work rolls are respectively 16½ in. and 19 in. in diameter and the backing-up rolls 53 in. in diameter. All the rolls have a body length of 42 in. The total horse-power of the driving motors for each mill is 2,500.

At this stage the coiled strip is destined to be either hot-dipped or electrolytically tinned. Until plant for the latter process is installed at Velindre, the strip will be hot-dipped at the Elba Works which are about 8 miles from Velindre and near Swansea Docks. They have been re-equipped for this purpose.

Three Ferrostan continuous electrolytic tinning units are to be installed. They are designed to operate at speeds of between 800 and 1,250 ft. per minute and are capable of producing tin

coatings of ¼ lb., ½ lb., ¾ lb., and 1 lb. per basis box and also intermediate weights.

The strip first passes through cleaning, pickling and scrubbing units, after which it goes through the plating section and is washed and rinsed before entering the melted-coating unit. Here the strip is heated to "flow-melt" and brighten the tin which has been electro-deposited on its surface. After quenching, the strip is passed through the chemical treating section where it is given a protective coating to prevent discoloration during stocking and to prepare it for any lacquering process to be applied subsequently. The strip is further protected by a thin film of cotton-seed oil which gives it the required lubrication for subsequent fabricating operations. The strip is then sheared into plate sizes of various widths and classified by visual and electronic inspection before being automatically counted and packed for delivery.

At the Trostre works tin-plate is being produced at an annual rate of 375,000 tons, and arrangements are being made to increase this output to 400,000 tons. When the Velindre Works reach full production at the end of 1958 the total annual output is expected to reach 800,000 tons. In addition it is calculated that 150,000 tons a year should be produced by hand mills.

EXTENSIONS AT MARGAM AND ABBEY WORKS

New developments at the Margam and Abbey Works, many of which are at the drawing-board stage but on some of which work is in hand, have been announced recently and are expected to increase the total ingot-steel output of the company to 3,000,000 tons per annum. These include 80 new coke ovens to supply an additional 7,200 tons of coke a week and a new No. 5 blast furnace to be erected alongside the No. 4 furnace, blown in last January. The No. 5 furnace will have a hearth diameter of 30 ft. 3 in. and will have a weekly output of more than 10,000 tons. This will increase the total pig-iron output to 40,000 tons a week.

A new melting shop, housing three 50 ton basic-Bessemer converters, is to be built on a site west of the Abbey open-hearth melting shop. The Bessemer shop will produce 12,000 tons of steel a week and oxygen-conditioned blast will be used. In this connection it is interesting to note that considerable progress has been made in the firm's open-hearth plants in the application of the use of oxygen to speed up the reduction of the carbon in the charge, in the lower-carbon ranges. In the blast furnaces it is proposed to make two grades of pig iron, one containing about 1·6 per cent. phosphorus and the other 0·4 per cent. phosphorus. The former will be for the Bessemer plant and the latter for the open-hearth plant.

The existing steel-ingot stripper bay will be extended and ten additional soaking pits, making a total of 34 pits, will be installed.

Other new developments which it was announced this summer are to be put in hand include a new slabbing rolling mill fitted with vertical rolls and capable of rolling 60,000 tons of ingots per week, a new 48 in. pickling line, a new 56 in. four-stand sheet cold reduction rolling mill, coil-annealing furnaces, and a new 56 in. temper rolling mill.

LOW OR HIGH FREQUENCY VIBRATIONS ABSORBED

MOUNTING REDUCES NEED FOR CONCRETE FOUNDATION

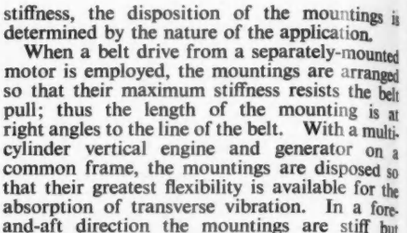
The Cushyfoot anti-vibration mounting introduced by Metalastik Limited, Evington Valley-road, Leicester, several years ago, is now applicable to a wider range of vibration frequencies, particularly low frequencies and shock loads.

They are produced in only two sizes but by varying the hardness and design of the rubber elements, loads of 200 lb. to 3,500 lb. per mounting can be supported with deflections which may be as high as ½ in. The ability of this mounting to meet many widely varying conditions is further increased by the different degrees of flexibility it offers according to the direction of the load. This variation is due to the method of construction.

Cushyfoot mountings are made from two castings united by oblong rubber-welded-to-metal sandwiches. The upper casting is attached to the machine base by a single bolt and its umbrella shape protects the rubber from damage and oil contamination. The lower casting is attached to the foundation by two bolts. In some cases it is possible to avoid the use of bolts or other positive attachment by means of rubber friction pads of narrow section. One of these pads is placed between the machine foot and the mounting, and a second pad is arranged between the mounting and foundation. Loaded vertically, the rubber sandwiches are in shear and compression, a combination which gives good deflection and high load-carrying capacity. A horizontal load applied longitudinally puts the rubber in shear and in this condition it is most flexible. To the horizontal load applied at right angles to the length of the mounting, the rubber is mostly in compression and is at its stiffest. To make full use of this variation in stiffness, the disposition of the mountings is determined by the nature of the application.

When a belt drive from a separately-mounted motor is employed, the mountings are arranged so that their maximum stiffness resists the belt pull; thus the length of the mounting is at right angles to the line of the belt. With a multi-cylinder vertical engine and generator on a common frame, the mountings are disposed so that their greatest flexibility is available for the absorption of transverse vibration. In a fore-and-aft direction the mountings are stiff but there is practically no vibration to damp out. When three or more mountings are disposed symmetrically about a vertical axis the stiffness of the suspension is the same in all directions. This disposition is particularly useful for centrifuges and other machines revolving about a vertical axis.

A deflection of 0·15 in. will cope satisfactorily with most vibrations above 1,000 cycles per minute but deflections of a much higher order are required for lower frequencies, and for shock loads. A deflection of 0·15 in. can be provided without much difficulty, but to obtain ½ in. or ½ in. in a mounting which is stable and easy to fit calls for considerable ingenuity.



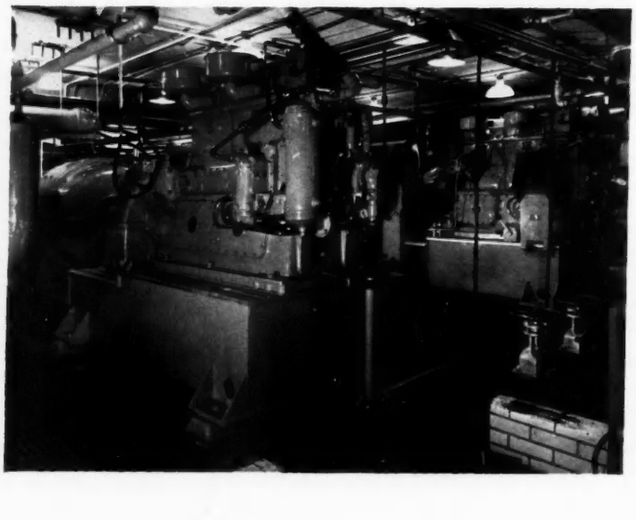
In the Metalastik Cushyfoot mounting, two rubber-welded-to-metal springs separate the top and bottom castings. Under vertical loads the rubber springs are in shear and compression. To horizontal forces, the rubber is in shear in one direction and mainly in compression under loads applied at right angles to the length of the mounting.

When first introduced the Cushyfoot provided 0·22 in. deflection under normal loads, and although adequate for most conditions, experience showed that this was not enough deflection to give satisfactory insulation for machines with running speeds as low as 500 r.p.m. and those giving rise to shock loads.

Cushyfoot mountings which provide deflections up to ½ in. are now available. Under shock conditions deflections of ⅞ in. are permissible without damage to the rubber sandwiches or the castings. This increase in deflection has been obtained without increasing the physical proportions of the mountings. Under load the height of the Cushyfoot which will support a ton and deflect ½ in. is less than 4 in.

The higher deflections now available have greatly extended the variety of installations which can be vibration-insulated without resort to the traditional block of concrete, thus greatly reducing installation costs and weight—the latter factor being of advantage if the subsoil is incapable of bearing great weight.

Special study has been given by Metalastik Limited to the mounting of Diesel generators, and a typical installation can be seen in the accompanying illustration, which shows A.E.C. Diesel generator sets housed in the basement of an office building. Cushyfoot mountings have been fitted under sets powered by more than 30 well-known makes of Diesel engines with 1, 2, 3, 4, 5 and more cylinders. Vibrations from sets with normal running speeds as low as 500 r.p.m. have been successfully isolated. Cushyfoot mountings are also well suited to such machines as power presses, pumps, grinders, drilling machines, centrifuges, vibrating screens and rotary blenders.



A.E.C. Diesel-engined generator sets mounted on Metalastik Cushyfoot units. The sets are in the basement of a large office building, where the absence of vibration is particularly desirable.

Book Reviews

BOOK FOR A GROWING TECHNOLOGY

Introduction to Chemical Engineering. By WALTER L. BADGER and JULIUS T. BANCHERO. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (9.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (71*s.* 6*d.*)

Until recently, those who had the ambition to qualify as chemical engineers, either by university study or by taking the examinations of the Institution of Chemical Engineers, generally relied on two textbooks. Both these were in the McGraw-Hill chemical engineering series and one of them, usually considered the more practical of the two, was *Elements of Chemical Engineering*, by W. L. Badger and W. L. McCabe. This was first published in 1931 and revised in 1936, and, in the preface to the first edition, it was emphasised that the book was intended for the "beginning student" or for the practising engineer who had not had extensive training in the underlying theory of the subject. The book was highly regarded as a "practical man's" book, although from the academic standpoint some of the text, particularly the chapter on the flow of fluids, could hardly be claimed to be rigorously correct.

Mr. Badger now has a new co-author and a new title, but the new book, *Introduction to Chemical Engineering*, cannot be regarded as other than a revision of the older *Elements of Chemical Engineering*, although no reference is made to this. Large sections of text and most of the drawings have been transcribed without change from the 1936 edition. It must be observed, however, that the theoretical background has in general been completely rewritten, and that a good attempt has been made to bring it up to date in the sections where significant advances have been made. For example, while the chapters on crushing and grinding and on conveying are virtually unchanged, the chapters on the mass-transfer operations, such as distillation, absorption, extraction, humidification and mixing, contain a lot of new material, mostly in the analytical approach to problems. This is in line with modern practice in teaching these "unit operations." The extent of the new material can be gauged by noting that, while the original book had a total of 660 pages, including appendices and index, the new book has 753 pages. One feature of the old book was a series of worked examples and questions for the student to tackle at the end of each chapter. The new book retains this feature, and the examples and questions are new.

The authors make it clear in their preface that the new book "has been written as a beginning engineering text" and it is intended to be covered by students in one year of study. As a consequence, it makes no pretence of being a comprehensive textbook covering the entire field. There is no doubt that it is a better book than *Elements of Chemical Engineering*, so that those who liked that book will like *Introduction to Chemical Engineering* even more, though the old weaknesses of the former have not altogether been eliminated. In the chapter on the flow of fluids, it is now conceded that the work done by a gas expanding in a flow process is $\int V\,dP$; the old book asserted it was $\int P\,dV$. The authors cling to the pound as the unit of force and also as the unit of mass, although they reduce confusion by referring to the latter as "pound-mass." They nave employed the growing practice of using the symbol g_c for the conversion of the units of force from poundals to pounds; indeed, they employ it where it would be correct to use gravitational g. For a flowing fluid, they call the velocity head $\frac{u^2}{2\,g_c}$, which it certainly is not. This persistence in not using consistent units, either poundals and pounds mass or pounds force and slugs, causes more confusion in a student's mind than anything else. It is a very long time since Lord Rayleigh, puzzled about engineering formulae, wrote "When the question under consideration depends essentially upon gravity, the symbol g makes no appearance, but when gravity does not enter into the question at all, g obtrudes itself conspicuously." The position has become no easier with the years.

In spite of this criticism, the book has some very good features. It is perhaps better than any other book in its illustration and explanation of the construction and operation of the various items of equipment described. Mr. Badger is one of the small number of pioneers who developed the profession of chemical engineering and is one of the most successful of its practitioners in the United States. He gives his point of view in the preface: "We differ absolutely from those who think that when a differential equation is integrated the problem is solved." This could be remembered with great advantage by all our schools of chemical engineering.

ELEMENTS OF SMOOTH RUNNING

Ball Bearing Maintenance. By J. RIDDLE. *University of Oklahoma Press, Norman, Oklahoma, U.S.A.* (5 dols.); and *Arthur F. Bird, 66 Chandos-place, London, W.C.2.* (42*s.* 6*d.*)

The number of books dealing with the various aspects of ball and roller bearings is all too few, considering the ubiquitous use of these components in modern engineering products, and published matter relating to their maintenance has been confined mainly to that issued by individual manufacturers. That the need for a comprehensive book on bearing maintenance exists is confirmed by the fact that, taken together, damage during fitting and incorrect mounting lead to more bearing failures than any other single cause. In any case, there can be few who doubt that the success or failure of a ball-bearing application, even when carefully designed with correctly selected bearings, depends very largely upon the attention paid to detail by fitters and maintenance engineers. The present volume therefore, should fill a very definite void and Mr. Riddle has covered the subject most thoroughly.

Being an American publication, the code symbols quoted in connection with cage materials, limits and accuracy, duplex bearings and end shields represent American makers' practice and are not those used by manufacturers in this country, most of whom have their own code systems. This fact, however, merely serves to emphasise the importance of following the advice given when ordering replacements, namely that every coded symbol should be quoted.

The use of the term "duplex bearing" to cover two single-row ball bearings mated to form a unit, might give rise to some misunderstanding. Certain manufacturers in this country offer a range of single-row angular contact ball bearings designed to take thrust in either direction, either with or without journal load, and it has been the practice for many years to describe these as duplex bearings.

Figures have been quoted for the permissible mal-alignment of the races of single-row rigid ball bearings; a matter that is frequently raised by bearing users. However, it must be kept in mind that this depends largely on the duty for which the bearings are to be used. Failures due to mis-alignment may be evidenced by cage wear or cage break up, or fatigue failure of the tracks at the areas of maximum stress. Under conditions of light load and low speed, when these components would normally be only lightly stressed, a bearing should, accordingly, operate satisfactorily with a greater amount of mis-alignment between its races than a similar bearing running at high speed and loaded to its capacity. Figures of this nature should, therefore, be used with discretion.

Fig. 66, illustrating the effect of bearing mis-alignment on the attitude of the cage to the races, is perhaps outside the scope of the average maintenance engineer, but those who consider this matter will probably agree that, for the configuration shown in the diagrams, the cage will actually be displaced to the left and contact the inner race at a point 90 deg. in advance of that indicated as the position of rubbing.

Care in the handling of bearings before fitting cannot be over-stressed and if the advice given on this matter alone were followed carefully, many bearing troubles would not occur. While the washing out of bearings which have been dipped in a rust-preventative oil is unnecessary, it should not be overlooked that some of the larger and heavier bearings are hot dipped in a mineral-jelly beeswax compound which forms a firm protective coating on the surfaces. This must be removed before fitting up, by submerging the bearings in hot oil.

The importance of investigating bearing failures and, where possible, applying corrective measures before fitting replacements is something that will be appreciated by all maintenance engineers. In this connection, the chapter "Common Failures and their Causes," is particularly comprehensive and includes a wide range of well-selected illustrations. Unfortunately, in practice, bearing failures are not always clear cut and, while there is usually a primary cause of failure, the evidence of this may be masked by one or more secondary features, so that extensive experience is essential to enable bearing troubles to be diagnosed correctly. However, this book should form a most valuable introduction to the subject, and, if all the guidance and information provided were acted upon, there would undoubtedly be a considerable reduction in the number of the machine breakdowns which are at present attributed to bearing failures.

FOR ENGINEERS' WIVES

Automation; Friend or Foe? By R. H. MACMILLAN. *Cambridge University Press, Bentley House, 200 Euston-road, London, N.W.1.* (8*s.* 6*d.*)

The author of this little book, which is based on a number of Third Programme talks, called in aid his wife to criticise it from the layman's point of view. It seemed reasonable, therefore, to this reviewer also to get the opinion of *his* wife on what is intended to be a popular exposition of this controversial subject. What follows is the opinion of a lady whose technical knowledge is confined to what she has acquired over a number of years by marital diffusion.

This is a book which, though geared to the "man in the street," manages to avoid both sensational scares and over-complacency in its conclusions, and over-simplification in its treatment of a not-so-simple subject. It deals with the present problems, the limitations, and the prospects of automation, and provides a history of the evolution of modern theory and practice; tracing, for example, the digital computer from its original form of the abacus, in order to emphasise the evolutionary character of to-day's developments.

The chapter on automatic control, and the author's subsequent attempt to explain to the uninitiated automatic inspection, negative feedback and the self-adjusting mechanisms, together with their practical incorporation in continuous-flow mechanised production, are clear and helpful and full of interest.

"Design Problems" forms the subject of another chapter, to which the above praise does not, however, so readily apply. It is too detailed, and, although in the end a pattern of argument appears, the more practically minded may at times feel themselves floating away somewhat in the discussions about multiple loops and the

human physiology, which seem a far cry from automatic production on the shop floor.

In the reference to diffraction gratings, the author's wife's efforts to " help him understand the layman's point of view " broke down when it came out of the blue and without further explanation; but this is an isolated lapse, and is more than offset by the fact that a whole chapter is devoted to a really lucid exposition of computing machines. This is in some ways the most exciting part of the book, possibly a reflection of the author's evident interest in the future role to be played by electronic computers—a future, moreover, to be measured in terms of " real time," and no longer a hazy dream. He sees them as automatic offices and, in the form of machine-controllers, as the only method fast enough to control the new rapid chemical reactions in modern chemical plants, and as a "must" in the master control of controllers in the modern automatic oil refinery.

The non-technical reader will enjoy the chapter on the automatic factory, describing the sort of methods that are already being used in the handling of various types of material, and the ingenuity of the brains behind the designs of the machines—in some cases demanding the re-design of the product to be processed. What comes out very clearly is that the engineer of the future is going to need a much higher degree of education than was called for in the days of the simpler mechanical methods, and it looks as if, properly handled by both sides of industry, the relieving of Man of the drearier type of repetition work should release him for more high-grade work, in which he can make his contribution to industry.

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NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

British Scientific Instruments, 1956. Directory and Handbook of S.I.M.A. *Scientific Instrument Manufacturers Association of Great Britain, Limited, 20 Queen Anne-street, London, W.1.* (22*s.* 6*d.*)

This directory of members of S.I.M.A. includes a classified list of products manufactured by them; French, German and Spanish glossaries; illustrated announcements by members; and a directory of associated members of the Society.

Measurement of Small Holes. By I. A. GRIGOR'EV. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (8*s.* 6*d.*)

This is a translation of a Russian book. In the first chapter the author discusses a series of tolerances for holes between 0·1 and 18 mm. diameter; in the second chapter he deals with contact devices and methods of measuring small holes, discussing the influence of the number and type of contact elements on the precision of measurement; the use of limit plug gauges in sizes below 1 mm.; and, finally, electrical contact and pneumatic contact methods. In the third chapter he covers contactless methods of measuring small holes:—optical projection methods, pneumatic methods and electrical methods. Chapter 4 is concerned with the specification of measuring means for inspecting small holes. A bibliography of 22 references is included.

Modern Rubber, Synthetic Rubber, and Thermoplastic Insulated Cables. By C. C. BARNES. *The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (6*s.*)

This design pamphlet discusses the various components of rubber, synthetic rubber, and thermoplastic insulated cables under the headings: the Conductor; the Dielectric (or Insulation); and Protective Finishes.

Reports on Plastics in the Tropics. 3: Aminoplastic Mouldings. 4: Phenolic Mouldings. Ministry of Supply. *H.M. Stationery Office, Kingsway, London, W.C.2.* (4*s. each.*)

Five batches of aminoplastic and 12 batches of phenolic moulding materials have been on exposure for two years at three humid sites in Port Harcourt and a dry site at Kano, Nigeria. Loss of surface gloss and discoloration of the surface occurred, being heaviest on specimens exposed to sun and rain. Brass inserts showed corrosion during the trial but in no case was there any deleterious effect on the surrounding plastic. Serious warping occurred on one batch of aminoplastic and one batch of phenolic mouldings. Weight and dimensions increased at the humid sites and decreased at the dry site. Resistance to impact showed a decrease at the humid sites, but an improvement shown at Kano after six months' exposure was not maintained. Decreases in volume and surface resistivity, and increases in power factor and permittivity, occurred at the humid sites, and the opposite in each case at the dry site.

British Plastics Year Book, 1956. 26th edition. *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1.* (35*s.*)

This classified guide to the plastics industry contains sections on patents; new companies; specifications; materials; manufactured products; and plant and equipment; a trade-names index and glossary of technical terms; a directory of plastics firms, organisations and consultants in the United Kingdom and overseas; a Who's Who of plastics personalities; details of associations and federations; and tables of technical and general data useful to the plastics industry.

Boundary Layer Effects in Aerodynamics. Proceedings of a Symposium held at the National Physical Laboratory on March 31 and April 1, 1955. *H.M. Stationery Office, Kingsway, London, W.C.2.* (30*s.*)

The nine papers comprising the International Symposium are as follows: " The Theory of Three-Dimensional Boundary Layers," by R. Timman; " The Axisymmetric Boundary Layer on a Long Thin Cylinder," by M. B. Glauert and M. J. Lighthill; " On the Stability of Three-Dimensional Boundary Layers, with Application to the Flow Due to a Rotating Disc," by N. Gregory, J. T. Stuart and W. S. Walker; " Contributions on the Mechanics of Boundary Layer Transition," by G. B. Schubauer and P. S. Klebanoff; " The Effects of Viscosity on the Type of Flow on Swept Wings," by D. Küchemann; " Some Recent Work on Methods of Boundary Layer Control," by R. C. Pankhurst; " The Profile Drag of Biconvex and Double Wedge Wing Sections at Supersonic Speeds," by A. D. Young and S. Kirby; " Interactions between Shock Waves and Boundary Layers and Wakes," by D. W. Holder and G. E. Gadd; " Some Effects of Shock-Induced Separation of Turbulent Boundary Layers in Transonic Flow Past Aerofoils," by H. H. Pearcey. The discussion following each paper is presented in summarised form.

Die Design Handbook. Published for the American Society of Tool Engineers by *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (14.50 dols); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (109*s.*).

Described in its sub-title as a " practical reference book on process analysis, product design, metal movements, materials, and proved die designs for every class of sheet-metal processing," the data given in the work are stated to be drawn from the technical resources of the American Society of Tool Engineers and hundreds of companies making and using dies. Among the subjects dealt with are stampings design, die sets and components, press feeding and unloading equipment, and materials for dies. The executive editor is Mr. F. W. Wilson.

Fused-Quartz Fibres: A Survey of Properties, Applications, and Production Methods. By NANCY J. TIGHE. National Bureau of Standards Circular 569. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (25 cents).

This survey of literature on fused-quartz fibres covers their applications, production and fabrication methods; mechanical properties of fibres; chemical and physical properties of fused silica; and a bibliography.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given though distribution is sometimes restricted.

Overhead Line Equipment. PIRELLI-GENERAL CABLE WORKS, LTD., Southampton and Eastleigh. Typical designs of a semi-standard nature with brief references to more specialised constructions. Details of fittings for transmission lines on poles for voltages up to 33 kV and for transmission lines on towers for voltages from 33 to 220 kV. Structures, such as standard radio and radio link towers and floodlight towers are also dealt with, as are aerial cable supports and ancillary equipment. There are a number of useful data sheets. Illustrated booklet. Reference OL 1: 1956.

Hydraulic Variable-Speed Gears. CARTER GEARS LTD., Bradford 3. Infinitely-variable speed gears of the positive displacement pump and motor type. Will pick up load from zero speed and give a stepless smooth range from about 35 r.p.m. to input speed in forward or reverse direction. Ratings from 0·33 to 3·50 h.p.; can be fitted with " Rite speed " gearboxes if desired. Illustrated catalogue giving constructional details, ratings tables and alternative controls.

Screwing and Cutting-Off Machines. CHARLES WINN & CO. LTD., Granville-street, Birmingham 1. Screwing and cutting-off machines for tubes and tube fittings, bolts and rods. For British, American, Unified, Metric and special threads. Cutting-off range ¼ in. to 8 in. diameter tubes. Screwing ¼ in. to 6 in. diameter tubes, ¼ in. to 3 in. bolts. Illustrated pamphlet.

Frequency-Modulated Tuner. H. J. LEAK & CO. LTD., Brunel-road, London, W.3. Tuning inductor in which the oscillator employs a trough line to give a stability of 10 kilocycles. The oscillator output is injected into the coupling between the radio frequency stage and the mixer, the network at this point being designed to attenuate second channel signals.

Infra-Red Lamps in Industry. PHILIPS ELECTRICAL, LTD., Shaftesbury-avenue, London, W.C.2. Infra-red lamps for baking, drying, degreasing, pre-heating and other industrial purposes. Technical data and tables of radiation intensities and relative spectral energy distribution. Details of 1,000 watt quartz infra-red heater for aircraft research. Illustrated booklet PL4778.

Light-Alloy Structures. HAWKSLEY-SMD LTD., Slough, Bucks. Aluminium framing and cladding, and other components, for buildings such as bungalows, stores, hospitals, hangars, schools, and for industry. Pictorial story of buildings designed and erected by company; also crane jibs, shelters, radio masts gangways, etc. Illustrated booklet.

Thermocouples. JOHNSON, MATTHEY & CO. LTD., 73/83 Hatton-garden, London, E.C.1. Thermocouples made from the noble metals for measuring high temperatures, up to about 2,000 deg. C. Theory, types of alloys, calibration and methods of use are discussed in a 40-page illustrated booklet written by H. E. Bennett, F.I.M.

Signal Generator. THE AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT CO. LTD., 92 Vauxhall Bridge-road, London, S.W.1. Signal generator capable of giving a constant signal at any point in the frequency range now allocated to broadcasting and television transmissions. Technical details. Illustrated leaflet.

Tropicalised Avometers. THE AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT CO. LTD., 92 Vauxhall Bridge-road, London, S.W.1. Certain components on four models of AvoMeter are now " potted " in an Epoxy casting resin and thus rendered suitable for use in the tropics. Illustrated leaflet.

High Performance Electromagnet. NEWPORT INSTRUMENTS (SCIENTIFIC AND MOBILE), LTD., Newport Pagnell, Bucks. A high performance electromagnet primarily for basic research, but also useful in radio, television and electronics. Technical details. Illustrated leaflet.

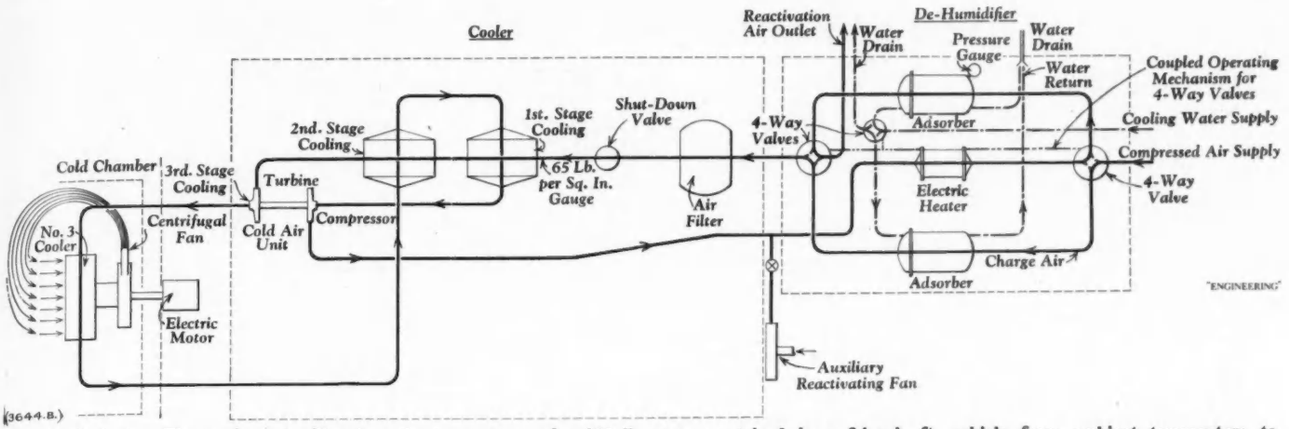
Portable Obstruction Light. LONDEX LTD., 207 Anerley-road, London, S.E.20. Portable obstruction light operated by two dry batteries for marking road hazards, excavations and accidents. Four extra lights can be operated from one master light. Illustrated leaflet.

Engines and Gearboxes. HENRY MEADOWS, LTD., Wolverhampton. Industrial, marine and automotive Diesel and petrol engines, ranging from 15 to 270 h.p., vertical or horizontal. Also gearboxes up to 800 lb. ft. torque. Catalogue with illustrations of engines and applications.

" Gridswitch." M. K. ELECTRIC LTD., Wakefield Street, Edmonton, London, N.18. Details of extended range of two-way switches, with flush and surface plates and other accessories. Illustrated leaflet.

Machine Tools. KRIESCHER & CIE, Lindemannstrasse 31, Düsseldorf, Germany. Full range of new, second-hand and overhauled machine tools offered for sale. Overhaul service for clients' own machine tools. Periodical lists of available machine tools.

Crush Barriers. TUBULAR BARRIERS LTD., Palace Chambers, Bridge-street, London, S.W.1. Portable stillages, 5 ft. long by 3 ft. 6 in. high, with wire-mesh panels; panel weight, 60 lb.; finish, zinc-rich paint. Illustrated Leaflet.



Layout of plant. The equipment will reduce the temperature of a 300 lb. mass contained in a 24 cub. ft. cubicle from ambient temperature to — 90 deg. C. in 1 hour and maintain this condition against a heat load of 2 h.p. per hour.

PORTABLE LOW-TEMPERATURE EQUIPMENT

RESEARCH REFRIGERATOR OPERATES ON AIR CYCLE

In response to a request from Boulton Paul Aircraft Limited, Wolverhampton, for portable refrigeration plant suitable for low-temperature research, Sir George Godfrey and Partners, Limited, Hampton-road, West Hanworth, Middlesex, have evolved a compact high-performance unit operating on the air-cycle principle, in conjunction with a cold chamber. The equipment under test is housed in the chamber which itself may also be portable. To operate the equipment all that is required is compressed air, electrical power for operating a fan, and cooling water.

The equipment had to meet the following specifications: (1) to cool a chamber of 24 cub. ft. capacity from ambient temperature to — 90 deg. C., and to maintain this temperature against a heat load of 2 h.p. per hour; (2) to cool a mass of 300 lb. from ambient temperature to — 90 deg. C. at atmospheric pressure, and to maintain this temperature; (3) the time to cool to — 90 deg. C. was not to exceed 1 hour.

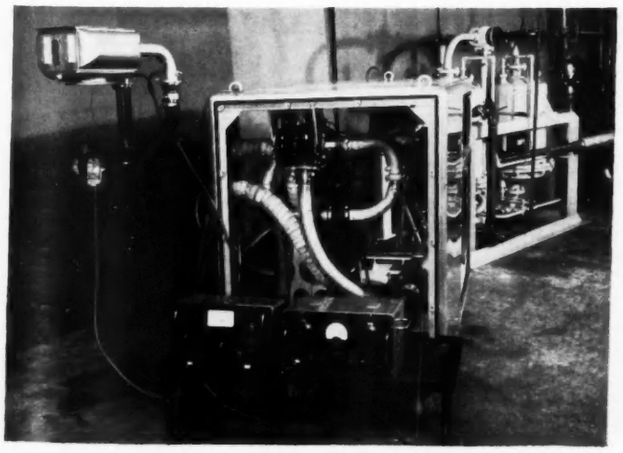
An outstanding feature of this equipment is the speed with which the cold-chamber temperature can be reduced from ambient to something in the region of — 120 deg. C. The exact time required to achieve the required temperature drop depends on the volume of the chamber and the heat load of the equipment being tested. A representative figure of 30 minutes can be quoted as the approximate time required to reduce the temperature of an empty chamber (adequately lagged), having a capacity of 200 cub. ft. from 20 deg. C. to — 100 deg. C.

In general the equipment is suitable for any application where extremely low temperatures are required in a short period of time. The small size and comparatively low weight of the plant, together with its portability and high performance endow it with great flexibility of operation.

In its present form, apart from the actual test chamber, the plant comprises two sections, a dehumidifier and a cooler. The dehumidifier is made up of two silica-gel adsorbers cross-connected by valves so that while one is in circuit the other is being re-activated. Water-cooled coils are employed to dissipate the heat generated during the air-drying process.

Air entering the cooler passes, in succession, through an air filter, a shut-down valve, two heat exchangers and an air turbine. It is then ducted to the cold chamber where it passes through a third heat exchanger and re-enters the cooler unit. During its return passage through the cooler, the air again passes through the two heat exchangers, this time across the direction of the initial inflow, and in the reverse order, i.e., across No. 2 heat exchanger, then across No. 1. It then passes through a centrifugal compressor which is directly coupled to the air turbine. Together, these two components comprise the cold-air unit.

Air discharged from the compressor re-enters the dehumidifier where it is heated before passing to the adsorber which is to be re-activated. It is then discharged to atmosphere.



The portable refrigeration plant comprises a dehumidifier (in the background) and a cooler operating in conjunction with a cold chamber.

The plant has a maximum refrigerating capacity of approximately 90 B.Th.U. per minute, and derives its energy from a supply of compressed air (charge air) at a pressure of 80 lb. per sq. in gauge. A mass flow of air of 20 lb. per minute is required, at a temperature not exceeding 25 deg. C. Each adsorber is capable of maintaining the charge air dew-point at a figure not exceeding — 30 deg. C. for a period of 2 hours. Thereafter the change-over valves are operated and re-activation begins; this continues throughout the period that the other adsorber is in circuit.

REGENERATIVE SYSTEM

From the adsorber, the air is ducted through a valve to No. 1 heat exchanger, where first-stage cooling takes place. Second-stage cooling takes place in No. 2 heat exchanger and the third and final cooling stage occurs during the expansion of the cooling air across the turbine. Third-stage cooling is a function of the work done by the turbine.

After leaving the turbine, the air enters the third heat exchanger in the cold chamber where it absorbs heat from the air drawn across the heat exchanger by a fan. In this way the equipment contained in the chamber is cooled. From this point in the system the temperature of the air progressively increases.

In re-passing through No. 2 and No. 1 heat exchangers heat is absorbed from the cross-flow of cooling air, subsequently a further temperature rise occurs across the centrifugal compressor. The power necessary to re-compress the air is derived from the expansion of "stage 3" cooling air across the direct-coupled turbine.

Air discharged from the compressor, at a high temperature and pressure, is ducted out of the cooling unit and through the electric heater. It is then passed through the adsorber which is out of circuit, where it evaporates the water, previously condensed from the charge air, and discharges to atmosphere. This drying process proceeds for 1½ hours, then the heater is shut down and the silica-gel bed is allowed to cool before again being brought into circuit. It will be apparent that the complete system operates on a regenerative principle in that, with one exception, heat and water are given up on the cooling side and re-absorbed on the re-heating side. The exception to this rule occurs in the cold chamber, where heat is given up to the airflow across No. 3 heat exchanger. It is at this point in the cycle that effective refrigeration takes place.

The plant is still in an early stage of development and it is expected that considerable improvements will be possible in respect of weight and bulk, where these are required. It is also possible that a completely self-contained unit will be made available to those operators who desire it. Such a unit will have its own prime mover and will be independent of external sources of air supply.

MANUFACTURE OF LONG FLUORESCENT TUBES

A RESULT OF CAREFUL RESEARCH

The demand for continuous lines of lighting and larger illumination areas has led Thorn Electrical Industries, Limited, 105 Judd-street, London, W.C.1 to produce 8 ft. fluorescent tubes in addition to the standard 2 ft., 3 ft. 4 ft. and 5 ft. lengths. For this purpose special automatic plant has been installed at the firm's Enfield factory and a new furnace room has been built in which the fluorescent powder is baked under controlled conditions. The introduction of these tubes has also necessitated the installation of a larger washing tunnel in which they are treated on their arrival at the works.

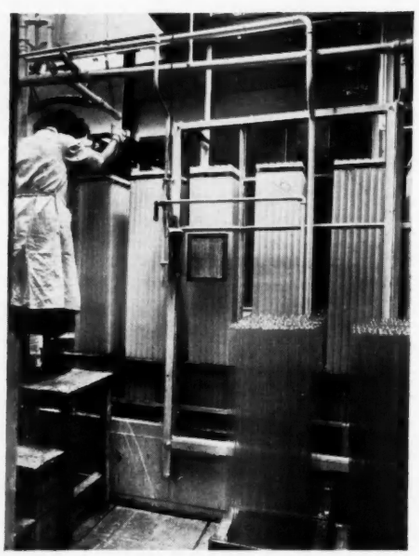


Fig. 1 Coating machine in which 63 tubes can be simultaneously flooded with fluorescent material in liquid suspension.

After drying the tubes are conveyed automatically to the coating room where they are flooded from the top with jets of fluorescent material in fluid suspension, as shown in Fig. 1, This method enables 63 tubes to be dealt with simultaneously. From the coating room the tubes pass through a " baker," which, together with the conveyor that subsequently takes them to an end-clearing and inspection bay, is capable of handling several thousand parts a day.

Next the stem assemblies, which have been manufactured on the high speed automatic unit illustrated in Fig. 2, are sealed into both ends of the tube on a special machine shown in Fig. 3, and are then carried by a conveyor to a finishing unit, which consists of an automatic pump, capping machine and ager. To facilitate handling on the group of machines which has been installed to deal with the 8 ft. tubes, a raised gallery on which the operators stand has been constructed.

LIGHT AND TEMPERATURE MEASUREMENTS

In addition to the production of these lamps an important activity at the Enfield factory is the bulk manufacture of fluorescent materials the total annual production of which amounts to some tons. Another vital section comprises the lighting laboratories where research is carried out on fluorescent materials and colour rendering and where incidentally the control gear for the 8 ft. tube was designed. An interesting item of equipment in this laboratory is a large photometer, which is used to measure the light output of various types of fittings under normal operating conditions. Temperature measurements are also made on all ranges of equipment, for although fluorescent lamps run at low temperatures the control gear in an enclosed fitting may become heated up to an extent which will affect its life. Stringent investigations are therefore made on all designs before they pass into production.

Tubes selected from the production units are also tested daily for light output and life up to several thousand hours, while tests are made in the " ballast " section on such control equipment as chokes, transformers and capacitors.

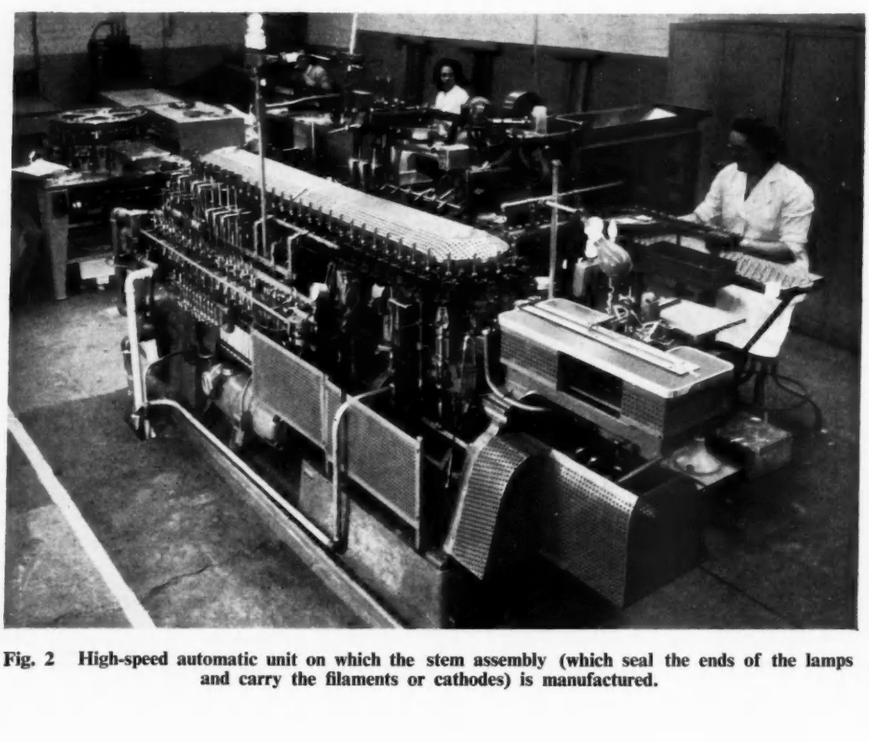


Fig. 2 High-speed automatic unit on which the stem assembly (which seal the ends of the lamps and carry the filaments or cathodes) is manufactured.

Fig. 3 Machine on which the stem assemblies are sealed in.

It may be added that many of the items in the new 8 ft. lamp manufacturing group have been built at Enfield where the machine department has its own jig-boring, optical angular divider and high-precision gear cutting machines, all of which are installed in a temperature-controlled enclosure.

* * *

MINIATURE THERMIONIC VALVE MANUFACTURE

Stringent Cleanliness Precautions

The manufacture of thermionic valves of both the miniature and "smaller-than-miniature" types necessitates that a high degree of cleanliness should be maintained in the production area.

This requirement is met in the new factory of Hivac, Limited, at South Ruislip, Middlesex, by using banel-vault-roof construction so that stanchions and roof girders are eliminated and by employing floors of polished wood blocks. The atmospheric pressure in the air-conditioned assembly shops is kept above normal to ensure that dust cannot enter from outside and the staff are provided with nylon head scarves and white overalls.

All the electrical, gas, water and other essential services are piped into the assembly section from a basement where the vacuum pumping machines are also installed. The connections between these machines and the valves, which are being evacuated on the production floor, are made through pairs of glands, one of which rotates with the evacuating machine, while the other is stationary. Each gland contains a ring of holes the lower of which is connected to the pumping plant and the upper to the heads of the valve machine. As the machine rotates in steps each valve is connected to the pumping plant and is thus evacuated. The surfaces of the glands are machined and lapped to ensure a vacuum-tight joint.

Even greater precautions are taken in the area where high reliability valves are manufactured. Here each bench is individually pressurised, while any condensation of the operator's breath on the components during assembly is prevented by glass screens.

AIR CONDITIONING

WALL MOUNTING UNITS FOR HEATING AND COOLING

A room air-conditioning unit with a cooling capacity equal to one ton of ice melting in 24 hours, or 12,000 B.Th.U. per hour, is now being made by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. It employs a 1 h.p. hermetically sealed motor compressor. Four models of the same overall size are available to meet the varying demands of different climatic conditions. One provides cooling only, another cooling and electric heating, the third cooling and heat pump, and the fourth cooling, electric heating and heat pump. The units are arranged to be built into a wall or window and can be flush with the inside or with the outside or in any desired intermediate position. The first case is shown in Fig. 1.

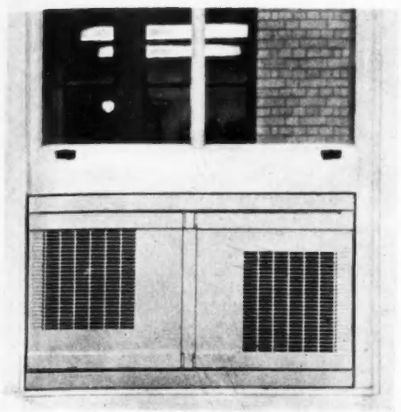


Fig. 1 The units can be mounted flush with the inner wall as shown here, flush with the outer surface, or intermediately.

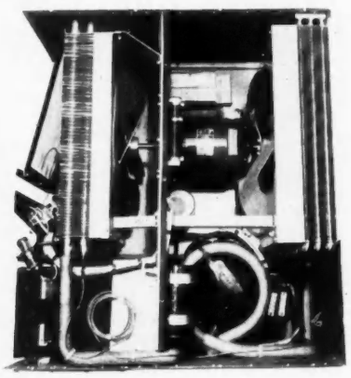


Fig. 2 A single motor drives both condenser and evaporator fans, and a sliding panel in the dividing bulkhead allows some fresh air to be drawn in.

When used for re-circulating and for conditioning room air only there are two entirely separate air circuits isolated from each other by the bulkhead which extends across the width of the unit (Fig. 2). Both the return (room) air and outlet (conditioned) air grilles are located on the front face. The air for cooling the condenser (outdoor coil) is drawn in through a diamond-mesh grille, passed through the condenser and out of the back of the conditioner. The inner, or room, air circuit is arranged so that air is drawn from the room, passed through a detachable and washable nylon mesh filter, cooled while passing through the evaporator and then returned to the room. The re-circulating capacity of the conditioner is 350 cub. ft. per minute, but if desired up to 65 cub. ft. per minute of this may be fresh air drawn from outside by means of a damper in the central bulkhead. Incoming fresh air is both filtered and cooled before it is discharged into the room.

So that the noise is kept to a minimum, only one motor is used for driving both the condenser and evaporator coil fans. The motor is a totally enclosed six-pole capacitor-start-capacitor-run machine fitted with sleeve bearings having large oil reservoirs and designed for continuous operation in temperatures up to 125 deg. F. As a further guard against noise, the motor is carried in a cradle having resilient suspensions.

The heat exchangers (condenser and evaporator coil assemblies) are constructed from refrigeration quality copper tubing to which aluminium fins are bonded. Both assemblies present large surface areas for a one-ton capacity air conditioning unit. This, in the case of the condenser, guards against high head pressures with resulting overload operation conditions.

All the units' controls, which are grouped on a central panel, are concealed but readily accessible. An electrical interlock is provided so that it is not possible for the motor compressor to be run unless the fan motor circuit has been closed.

Electric heating is incorporated in the V.3513 model by three 500 watt elements fitted in the discharge air stream. The heater elements have two distinct and different functions: first when used with the fan only (there is an electrical interlock to prevent the heater being switched on without the fan) they provide a small (5,120 B.Th.U. per hour) source of heat for the occasional sudden drop in ambient temperature. Secondly, when humidities are uncomfortably high at a time when the ambient temperature is somewhat lower than normal, it is possible to dehumidify by running the motor compressor and fan, using the heaters for re-heat purposes so as not to provide uncomfortably cold conditions.

A reverse-cycle heat pump is included in the V.3514 model, a feature of value where there is a marked contrast in day and night temperatures. Once the thermostat is set to the required temperature the unit will automatically change over from cooling to heating and vice-versa according to the rise or fall in temperature, thus maintaining constant comfort conditions in the room irrespective of the outside ambient temperature. The reverse-cycle heat pump has the effect of changing over the functions of the condenser and evaporator coil assemblies. With an outside temperature of 40 deg. F. and a room temperature of 75 deg. F., the unit has a heat output of 12,200 B.Th.U. per hour (= 3·5 kW approximately).

Electric heaters and the reverse-cycle heat pump are both incorporated in the V.3515 model. As in the V.3513 model the electric heaters are not controlled by the thermostat and may be used (with the fan) as a continuous source of heat if desired.

MOBILE COLLIERY WINDER

A mobile winder, the main contractors for which were the English Electric Company, Limited, Kingsway, London, W.C.2, is now in use in the Northern Division of the National Coal Board. It consists of a towing vehicle and a trailer, the former carrying a Diesel engine driven generator and the latter, of which an illustration is given herewith, the electrical equipment.

The English Electric Diesel engine has an output of 195 b.h.p. at 1,250 r.p.m. and is connected to a 78 to 127 kW shunt-wound generator, which supplies direct-current at 320 volts. The winder motor is rated at 95 h.p. at a speed of ± 0 to 1,000 r.p.m. and drives a drum, which is 4 ft. in diameter by 3 ft. wide, through double reduction gearing. The equipment is controlled on the Ward Leonard system and is designed to sustain a rope-end load of 2 tons at a maximum speed of 8 ft. per sec. for winding depths up to 3,000 ft. It is provided with a depth indicator, signalling and telephone equipment, oil pressure operated brakes and the protective features commonly found on the larger types of stationary winding equipment.

The trailer, which was supplied by Messrs. Robey and Company, Limited, Lincoln, is fitted with railway wheels, in addition to road wheels, while the towing chassis which was provided by A.C.V. Sales, Limited, 40 Berkeley-square, London, W.1, is capable of towing the trailer over very rough ground. The two vehicles can be coupled electrically by trailing cables fitted with mining " flit " plugs to facilitate connections.

The winder described is now being employed at the Newburgh Colliery, Northumberland, where the shaft is used for draining other pits in the neighbourhood and where the main winding engine has been dismantled.

Electrically operated mobile winder now in use in the Northern Division of the National Coal Board.

The Machine Tool Industry (*continued from page* 28)

This week we publish a further group of articles on the machine tool industry, continuing our plan to draw attention to developments in machine tool design that have occurred in recent years. After concluding the article on turning, screwing and threading with some additional remarks on automatic lathes and sections on copy turning, screwcutting, thread rolling and allied operations we shall deal with cutting fluids and slideway lubrication, furnaces and heaters and woodworking machinery. Previous articles in the series have discussed automatic control systems, machining light alloys, spark erosion, welding equipment, and drilling, boring and milling.

TURNING, SCREWING AND THREADING

(*Concluded from page* 28)

In the conclusion of our article on turning, screwing and threading, we give some further information on automatic lathes, and discuss copy turning, the machining or forming of threads, and certain miscellaneous operations loosely associated with turning.

AUTOMATICS

Originally developed in Switzerland for producing components for the watch and clock industry, the Petermann sliding head automatic operates on a different principle from the machines previously mentioned. A modern version of this machine, the P16, exhibited by Charles Churchill and Company, Limited, has a bar capacity of $\frac{5}{8}$ in. and a headstock travel of 3·94 in. There are six tool-holders arranged radially round the axis of the machine, each tool being operated independently by means of cams. An alternative to the standard working end of the machine, which has attachments for centring, drilling and threading, is a six-position turret for end-working tools. The spindles in this drum-type turret can be either rotating or stationary, or in any sequence of the two, and they can also be employed equally well for drilling, tapping, or external threading.

A variant of the sliding-head principle is the French "Motobloc" sliding-head automatic chucking lathe exhibited by Acbars, Limited, and shown in Fig. 10. It has a sliding headstock with a cam-controlled maximum movement of 4½ in., and two vertically-mounted tool holders, which are also under cam control. The spindle has 28 speeds in two ranges, 210 to 2,500 and 375 to 4,100 r.p.m. The tailstock is hydraulic, and acts as a follower, moving with the sliding headstock. It is also used for drilling, with a rapid advance and slow feed. A pneumatic chuck is fitted, and if desired the machine can be set up to run entirely automatically (when the work pieces are suitable) with feeding, chucking, machining and ejection of the pieces under cycle control. Push button controls are provided for hand control when the size or shape of the components makes automatic operation impossible.

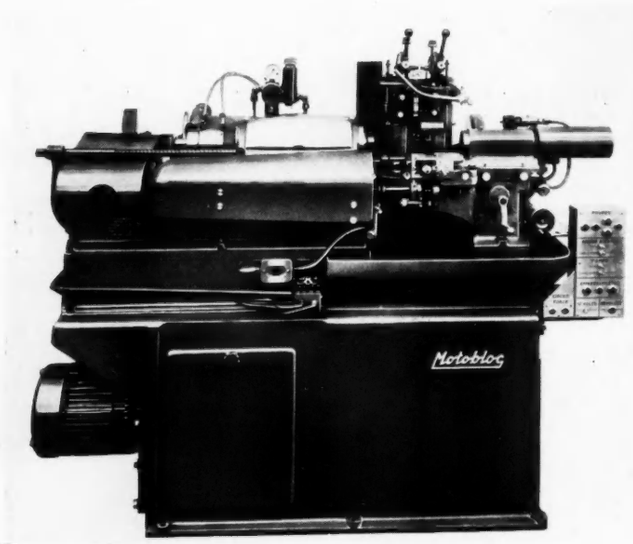


Fig. 10 Sliding-head automatic chucking lathe. (Acbars, Ltd.)

MULTI-SPINDLE MACHINES

Automatic lathes of the multi-spindle type have also been built for a considerable number of years, and the basic principles remain unchanged. Like the single-spindle type the multi-spindle machines are available for both bar and chucking work, and in both forms the main improvements in recent years have been in detail, leading to higher production rates and simplified setting and maintenance. Some high speeds were demonstrated by machines in operation at the Exhibition. A 1 in., six-spindle, machine from the comprehensive range of Wickman, Limited, P.O. Box 44, Banner-lane, Tile Hill, Coventry, for example, was producing two brass components at each indexing, in a cycle time of 1·99 seconds. Another machine by the same manufacturer, produced, in a cycle time of 9·6 seconds, with 14 tools, a mild steel component with seven external and four internal machined diameters, a rolled thread behind a shoulder, a rolled marking, a tapped thread, with facing and ending to length.

A new machine, the B.S.A. Acme-Gridley eight-spindle automatic, which is shown in Fig. 11, has been added to the range made by B.S.A. Tools, Limited. This typifies the more complex type of automatic bar machine, which is capable of very high speeds and can produce complex components with such additional operations as cross-drilling, thread chasing or milling, for which a second operation would otherwise be necessary. Another important advantage claimed for this machine is that it can do the work of two four-spindle machines, with a consequent saving in floor space. It has a capacity of $1\frac{3}{8}$ in. diameter in round bar, $1\frac{9}{64}$ in. square, or $1\frac{13}{32}$ in. hexagon, and has a turning length of 8 in., with a stock feed of 10 in.

A smaller group of automatic chucking machines, the vertical type, is well represented by the "Verticalauto," made by Thomas Ryder and Son, Limited, Turner Bridge Works, Bolton. The products of this firm are well known, and the design of the No. 10 model, which has been on the market for about 12 months, is based on experience in the manufacture of this type of machine extending over many years. The machine is made in two versions, six and eight spindle. In the six-spindle version the machine has a swing capacity $19\frac{7}{8}$ in. in diameter and is equipped with five turning and four facing slides. As an eight-spindle machine it will swing up to

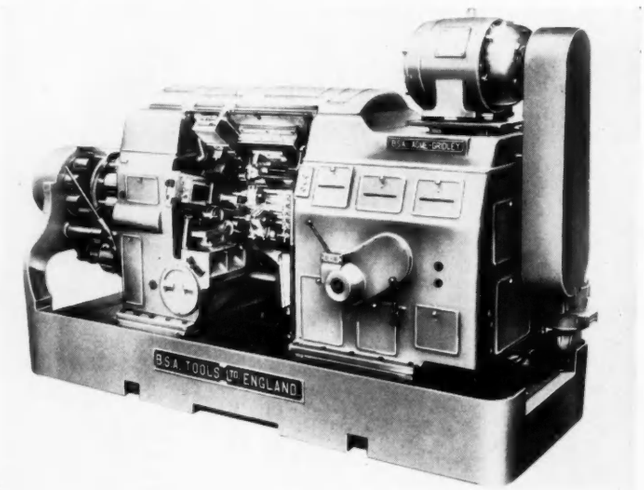


Fig. 11 Eight-spindle automatic bar machine, capable of second-operation work such as cross-drilling or milling. (B.S.A. Tools, Ltd.)

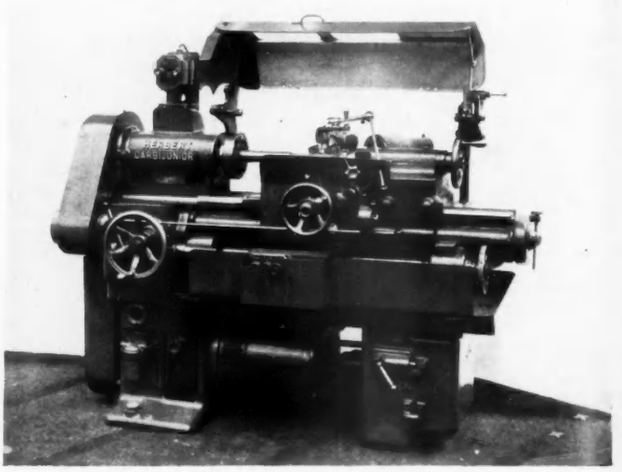


Fig. 12 Centre lathe with built-in hydraulic copying attachment. The machine can be used either for copy-turning or as a centre lathe. (Alfred Herbert, Ltd.)

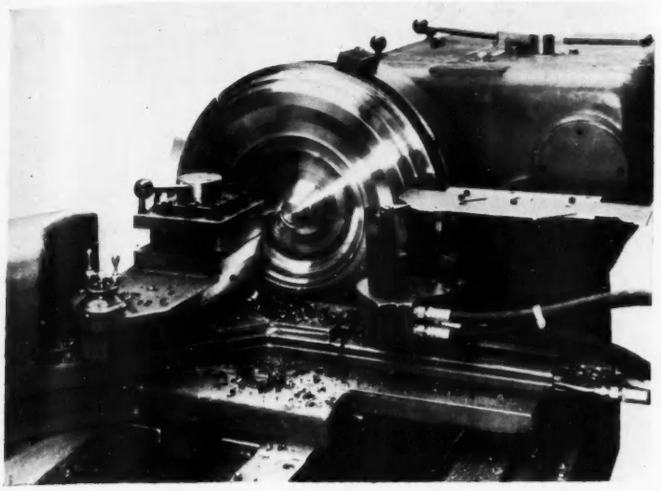


Fig. 13 Face machining under control of a full-size template. (Denham's Engineering Co. Ltd.)

Fig. 14 Copy turning machine, with fully automatic work cycle including control of feeds and speeds. (Leo. C. Steinle, Ltd.)

15½ in. diameter, and has seven turning and four facing slides.

The control is of the electro-hydraulic type, hydraulic mechanisms operating the chucks, clutches or spindle drives, spindle brakes, location of spindle carrier after indexing, and clamping of carrier during cutting. The chuck movements are manually controlled, but all others are part of the automatic machine cycle, solenoid-operated pilot valves being actuated by cams on a timing drum to control the various movements. The electro-hydraulic system not only provides a convenient method of control, but also enables numerous electric, hydraulic and mechanical interlocks to be incorporated to counteract errors in operation or incorrect setting of the machine.

COPY TURNING

The idea of controlling the cutting tool of a machine by means of a model or a template, and so producing any required number of identical components is far older than is generally appreciated, but it is only in comparatively recent years that the principle has come into widespread use. The copying principle is, of course, applied to many other types of machine than lathes, but such machines have no place in the present article. Like other forms of machine tool the copy-turning lathe takes several forms, and is made with different degrees of complexity, according to the work for which it is intended. The types in production range from attachments designed to be fitted to standard machines, to modifications of normal centre lathes, and specially-designed copying machines intended on high-speed production.

An example of the first type of equipment is the "Copyrite" attachment made by S. N. Bridges and Company, Limited, Parsons Green-lane, London, S.W.6. This is a simple hydraulic mechanism, with a copy-holder at the rear and a diagonal slide and tool-holder. The attachment does not affect the normal functions of the lathe to which it is attached. It is also suitable for use with milling and shaping machines.

A good example of the modified centre lathe is the "Carbijunior" made by Alfred Herbert, Limited, Coventry. It is illustrated in Fig. 12. This machine is basically a centre lathe and can be used as such for ordinary turning work, or to produce its own master or copy component when it is to be used for copy-turning. The copying slide is mounted in the position normally occupied by the rear tool post. It is hydraulically operated, and works from a master component mounted on centres behind the lathe bed. A free-standing hydraulic power unit at the rear of the machine completes the equipment.

TEMPLATE COPYING

Copy turning may be controlled by a master specimen of the desired finished component, or by a template, and it can be as easily applied to facing as to turning. An example of the template-controlled facing type of copying is provided by Fig. 13, which shows a machine made by Denham's Engineering Company, Limited, Holmfield, Halifax, working with a Denham-Metropolitan-Vickers hydraulic copying attachment. The lathe is a new Denham model of 14¾ in. centres, with a disc 25 in. in diameter being machined, the operation involving cutting both in front of and behind the centre line for re-entrant angles. The use of the template is clearly visible in the illustration.

COPYING WITH AUTOMATIC WORK CYCLE

The specially-designed copy-turning machine, of which Fig. 14 is a typical example, is a complex machine capable of fully-automatic operation in the work cycle between the manual loading and unloading operations. The machine illustrated, which is designed for heavy stock removal, is a German-made Heyligenstaedt, exhibited by Leo. C. Steinle, Limited, Mackadown-lane, Kitts Green, Birmingham, 33. It is normally supplied with a two-cut automatic cycle, which allows for a roughing and a finishing cut. A six-cut cycle is also available. This is of value where stock removal is heavy, as the machining is then done cut by cut. The machine works automatically once it has been loaded and the cycle has been initiated by the operator. The automatic cycle includes control of the cutting speed, pre-selected feeds, jump feed for sections which do not require machining, and rapid return of the copying slide to its start position.

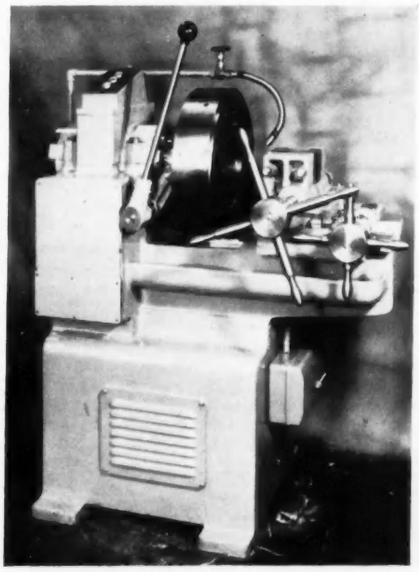


Fig. 15 Universal screwing machine for bolts up to 2 in. and pipes up to 4 in. in diameter. (Joshua Heap and Co. Ltd.)

SCREWING AND THREADING

Many specialised machines are used in the manufacture of nuts, bolts and screws which are peculiar to the trade concerned, and are not applicable to engineering generally. Nevertheless, a considerable amount of screwing of one kind or another is done in establishments other than those concerned primarily with the production of screw fastenings, and several machines were shown at the exhibition which were of general engineering interest.

Of all the specialised screwing machines those which use a tap or die are the oldest. They have developed over a long period into reliable and useful machines of wide application, and can be divided into two groups, those which use dies, and those which screw by means of taps, though the two types are often interchangeable to some extent. An example of the former group is the 4 in. universal screwing machine exhibited by Joshua Heap and Company, Limited, Ashton-under-Lyne. This machine, which is illustrated in Fig. 15, has a cam-type radial die head, which can be opened and closed by a bow fork and hand lever while the machine is running. It is capable of screwing bolts from ¼ in. to 2 in. in diameter and pipes from ¼ in. to 4 in. in diameter.

Another threading machine of general engineering application is the tapping machine, of which the vertical type, similar in appearance to the pillar drilling machine, is typical. This type of machine has, in fact, much in common with the ordinary drilling machine, but its standard range of spindle speeds is different, and the spindle drive is designed to be capable of repeated reversals. A machine of this type is illustrated in Fig. 16. It is the British-built Huller tapping machine, exhibited by B.S.A. Tools, Limited. The Huller machine illustrated, which is one of a range covering tapping up to 1⅜ in. in diameter, has an automatic tapping cycle, and is therefore suitable for use with a loading magazine, which renders it fully automatic in operation.

FORM GENERATION BY ROLLING

The only really revolutionary development which has taken place since screw threads were

Fig. 16 (Left) Vertical tapping machine, one of a range extending to 1 3/16 in. in diameter capacity, with automatic tapping cycle. (B.S.A. Tools, Ltd.)

Fig. 17 (Right) Centreless turning machine for bars up to 3 in. in diameter. Machining cycle is automatic. (Sir James Farmer Norton and Co. Ltd.)

first used is that of thread rolling. Its advantages are so well known as to need no comment, and the process is used for the production of a large proportion of the screw fastenings made to-day. Machines for thread rolling are, of course, purely special-purpose machines, though they can be used to produce many different kinds of thread and certain other forms such as knurls, serrations, and oil grooves as well.

The " Pitchmaster " thread roller, which is illustrated in Fig. 18, is an example of this type of machine. It is made by the W.S. Manufacturing Company, Limited, Birmingham, 15, and was exhibited by Drummond-Asquith (Sales), Limited, King Edward House, Newstreet, Birmingham, 2. The " Pitchmaster " can roll threads up to 1½ in. in diameter, and on continuous lengths will work at an average speed of 17 in. of thread per minute. When components are of uniform diameter throughout a magazine feed enables them to be fed to the rolls automatically, with a production rate of up to 1,000 per hour. When the components have eccentric projections the machine is fitted with a semi-automatic feeding attachment.

SPECIAL-PURPOSE TURNING MACHINES

One or two machines were exhibited which do not fall into any of the classes so far mentioned, but which should certainly be included in the broad classification of machines for turning. Such a machine is the " Tornamat," made by Hahn and Kolb, of Stuttgart, Germany, and exhibited by Sidney G. Jones, Limited, 8 Balhamhill, London, S.W.12. This machine, which has hydraulic feed and has been designed with particular regard to tungsten-carbide tooling, is a purely special-purpose model for the production, by turning, of polygonal shapes. It is equally well suited to the machining of two parallel faces, such as spanner flats, squares and hexagons.

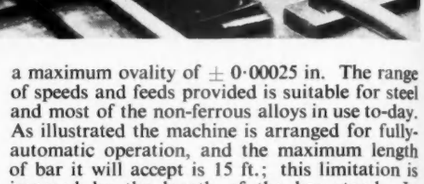
Another special-purpose machine is illustrated in Fig. 17. This is the centreless bar-turning machine exhibited by Sir James Farmer Norton and Company, Limited, Adelphi Ironworks, Salford, 3. It is designed for centreless turning of bars from ½ in. to 3 in. in diameter, with a maximum error of ± 0·001 in. in any 20 ft. length, and a maximum ovality of ± 0·00025 in. The range of speeds and feeds provided is suitable for steel and most of the non-ferrous alloys in use to-day. As illustrated the machine is arranged for fully-automatic operation, and the maximum length of bar it will accept is 15 ft.; this limitation is imposed by the length of the bar stand. In operation, the ingoing stand is loaded with black bars, and the machine automatically lowers the first one to a travelling carriage, which grips it hydraulically and feeds it into the turning head. As the turned bar emerges it is gripped in the same way by the outgoing carriage, and traversed clear of the turning head. Finally, the machine lifts the turned bar to a stand, where it can await disposal.

CHECKING GEAR PROFILES

A portable instrument for checking the profiles of gear teeth has been produced by David Brown Tool Division, Park Works, Huddersfield, and is shown in the accompanying illustration. It is primarily designed for use on large-diameter gears where the teeth have a circumferential pitch of about ¼ in. or more and the accuracy of profile has to be closely maintained. The range, however, is fairly large and it can satisfactorily be used for gears from 18 in. diameter up to 16 ft. or more. It can be used equally with spur or helical gears. The instrument stands on the wheel on three spherical locators which rest between the teeth; six sets of these locators are provided ranging from 5/16 in. to ¾ in. in diameter. Horizontal and vertical slides are traversed by micrometer screws and can be set in any desired position to within 0·0001 in.

The stylus is first brought into contact with the outside diameter of the gear tooth and the vertical thimble is set to zero. The stylus is then moved into the gear space and downward equal to the distance of the first vertical co-ordinate plus the radius of the stylus sphere.

The horizontal head is then moved to enable the stylus to contact the flank of the tooth and the horizontal thimble and dial indicator are set to zero. The stylus is then withdrawn into the space and moved downwards the distance of the second vertical co-ordinate and the horizontal slide traversed until the stylus contacts the flank. The operation is then repeated down the flank at the predetermined vertical co-ordinates thus giving the actual profile of the gear being checked.



By moving the stylus with the horizontal and vertical micrometer heads, the profile of the gear tooth can be checked.

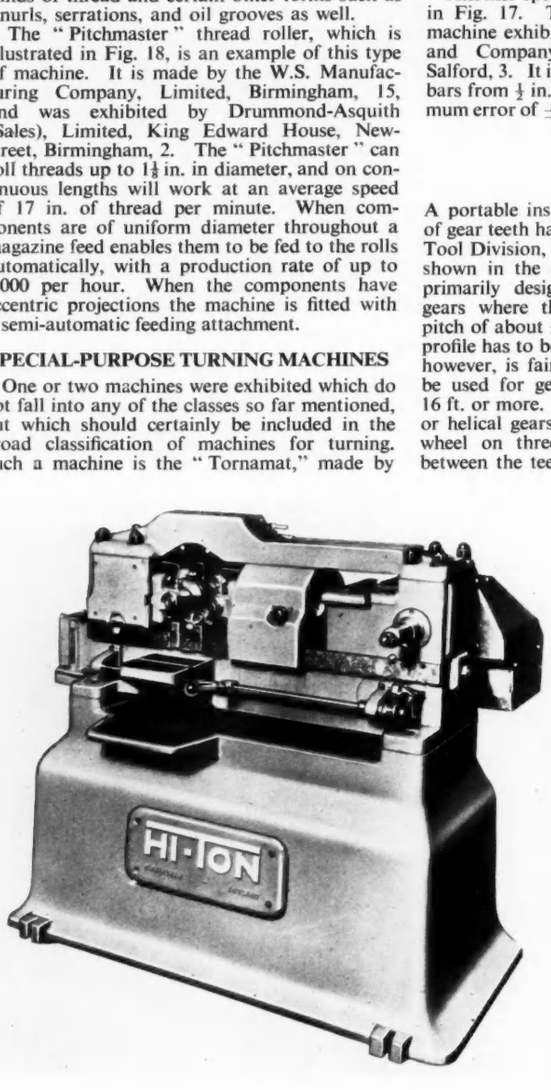


Fig. 18 Thread-rolling machine with automatic or semi-automatic feed according to component. Will also roll other forms such as knurls. (Drummond-Asquith (Sales), Ltd.)

The Machine Tool Industry

CUTTING FLUIDS AND SLIDEWAY LUBRICANTS

Many developments in cutting coolants are closely associated with developments in metallurgy and production engineering. To a lesser degree, developments are initiated by the manufacturers of cutting coolants with such objects as increased efficiency and economy in use, and the welfare of the machine operator.

War-time exigencies brought about the development of many new processes. The employment in aircraft manufacture of metal alloys previously unused, and the need for faster and greater production, has made heavy demands in the cutting-coolant field.

Machining tough and high-tensile alloys presented problems to the toolmaker and the cutting-coolant manufacturer. The increased friction—and subsequent high temperatures generated at the cutting edge—blunted the tool, producing rough finishes, caused built-up edges welding on to the tool face and, finally, the complete destruction of the tool itself.

In recent years the use of the nickel alloys of the Nimonic series has brought further machining difficulties, beyond the capacity of normal high-quality cutting coolants. It has, however, been found that the addition to them of certain ingredients increasss their ability to maintain a protective film between the tool face and the work surface.

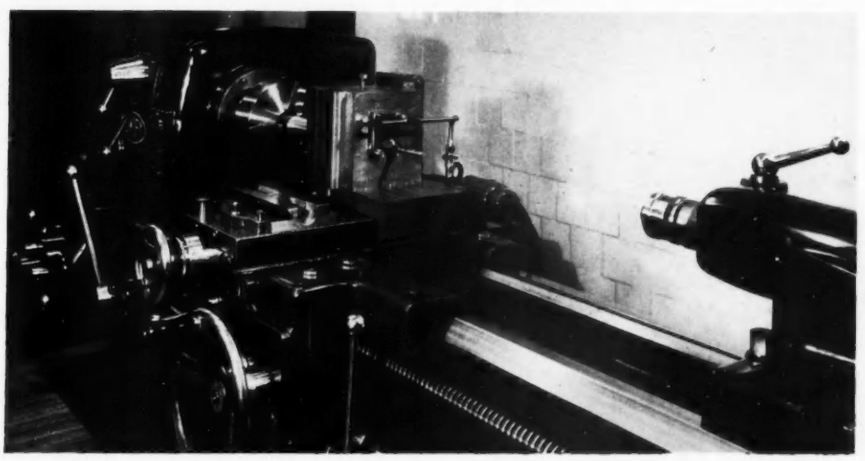
EXTREME-PRESSURE CUTTING OILS

Hitherto fats, and a combination of fats and sulphur, have given a measure of success when used neat, but were less successful with the water-soluble type of coolant. Now, chlorinated compounds soluble in both water and oil have proved highly successful in both types of coolant, resulting in higher cutting speeds and longer tool life.

Among these newer types of extreme pressure oils, Alexander Duckham and Company, Limited, Hammersmith, London, W.6, offer Q.5091, an opaque type soluble oil with an extreme pressure additive to render it suitable for machining high-nickel alloys; Transcut 130, a clear soluble oil which can be used as an alternative to neat oil on capstan and semi-automatic lathes; Kemcut, a compound neat oil with additives suitable for gear-cutting, shaving, thread cutting, grinding, tapping and rolling of all grades of steel; L.O.1 Supercut, a neat oil based on fatty oil substitutes, which is suitable for gear-cutting, thread cutting, rolling, tapping, milling and broaching of the tougher alloy steels, with ultimate strengths of 80 tons per sq. in. and higher; and Q.5029, a sulpho-chlorinated fatty oil, specially developed for the Nimonic alloys.

The Manchester Oil Refinery Limited, Trafford Park, Manchester, have developed Halmor 9, a low-viscosity active sulpho-chlorinated oil for high-tensile and work-hardening alloys, particularly suited for operations such as deep drilling and internal broaching; and Halmor 10, a relatively high-viscosity oil for arduous operations of the slower type on extremely tough materials. Their Ferromor A and B are sulphurised oils for machining medium and higher tensile steels, Ferromor B containing a higher proportion of additive for heavy-duty work. Neither of these oils is recommended for machining non-ferrous alloys; neither is Swift R.C., a sulpho-chlorinated neat mineral oil developed by Fletcher Miller Limited, Alma Mills, Hyde, Cheshire, for gear cutting, broaching and the general machining of difficult ferrous and nickel alloys. Fletcher Miller Limited have also introduced recently a group of dual-purpose sulphurised fatty mineral oils, the Swift S.S. series. The three oils in this series cover a range of viscosities and are suitable respectively for light machining and repetitive work, medium-duty and heavy-duty cutting operations; all are suitable for use with both non-ferrous and ferrous metals.

The use of titanium for jet-engine components, turbine blades, and jet nozzles has necessitated the development of new types of extreme-pressure cutting lubricants in order to place the machining of titanium on a routine production basis. A neat oil, Q.5204, produced by Alexander Duckham and Company, Limited, and containing a concentrated chlorinated additive is one of these oils, specially developed for the tapping of titanium.



In Duckham's machinability laboratory, radioactive cutting tools are used to expedite the assessment of cutting coolants and the machinability of metals. To protect the operator, of a 15 h.p. Swift lathe with spindle speeds from 20 to 1,500 r.p.m., the cutting is done in a totally-enclosed 1 in. thick steel chamber.

STABLE ANTI-CORROSIVE EMULSIONS

With water-soluble cutting coolants greater stability in use and better anti-corrosive properties have always been demanded. The use in post-war years of improved emulsifying agents and certain inhibitors has gone a long way towards meeting these demands, and longer effective life with greater rust control are now the rule rather than the exception.

Transcut 50, a clear oil developed by Alexander Duckham and Company is typical of a modern soluble oil for general use in the machine shop. Another clear soluble oil of high stability is Almaredge, a neat fatty sulphonaphthalenic coolant developed by Fletcher Miller, Limited, a useful oil where standardisation is sought, suitable for cutting steels, cast-iron and non-ferrous materials. It is particularly recommended for cutting ferrous stock at high dilutions with marked anti-rust properties and effective control of the rate of tool wear.

With the increasing use of grinding operations in modern production attention has been focused on grinding fluids. Hitherto, these consisted of either a solution of common soda and water or a soluble oil—both efficient coolants, but with drawbacks. Soda solutions are ineffective as corrosion preventives and soluble oils form a grease-like film on the grinding wheel. This film binds swarf particles extracted from the circulating fluid to the wheel surface resulting in unsatisfactory finish of the work, unnecessary wheel dressings and an undue percentage of spoilt work.

OIL-FREE GRINDING FLUIDS

The development of chemical oil-free grinding fluids has overcome these disadvantages. Diluted with water to form true solutions, these fluids provide a coolant which keeps the grinding wheel in a free-cutting condition, is easily filterable and maintains the machine and the finished component in a rust-free condition.

Among these are Alexander Duckham's Transcut 27, a synthetic oil-less grinding fluid giving free-cutting conditions, high finish and excellent rust control. Alvarene grinding fluid, developed by Fletcher Miller, Limited, an oil-less soluble coolant, translucent and mildly alkaline, is also noteworthy for its effectiveness and anti-corrosive properties when grinding ferrous metals at extremely high dilutions. Although the recommended dilution range is from 1 in 60 to 1 in 120 several firms use it on iron and steel at 1 in 200 without rusting. It is specially useful for grinding open-grain cast irons which are prone to rust quickly after being machined.

Dromus oil E, a grinding fluid supplied by Shell-Mex and B.P. Limited, Shell-Mex House, Strand, London, W.C.2, is a concentrated solution of a complex mixture of chemicals which, unlike soluble oils, can be added to water or vice versa. The main loss of the coolant is by evaporation, so that in many cases machines can be run with this fluid for considerable periods, topping up with water. At the recommended concentrations of 60 to 1 to 80 to 1 Shell Dromus E is stated to give good protection against corrosion.

Another new transparent oil-less grinding fluid is S.764, developed by Sternol Limited, Royal London House, Finsbury-square, London, E.C.2, for use at dilutions up to 100 to 1. Using this fluid the grinding wheel is kept open and glazing is prevented. It is much used in the cutlery trade and is also suitable for general machining operations.

BROACHING FLUIDS

In recent years broaching has become a more widely used operation, particularly where mass production methods are employed. One of its disadvantages has been the high cost of broaches and their tendency to break. Special cutting lubricants with chemical additives, however, have helped to make this operation more economical.

For the milder steels and non-ferrous alloys, Alexander Duckham and Company, Limited, recommend their broaching paste, B.P., and for high-tensile steels their neat oil, L.O.1 Supercut, referred to above. Other oils specially suited to heavy-duty broaching operations are the Manchester Oil Refinery's Halmor 10 and the Ilocut range of neat oils developed by Wakefield-Dick Industrial Oils, Limited, 46 Grosvenor-street, London, W.1. Fletcher Miller's Swift R.10

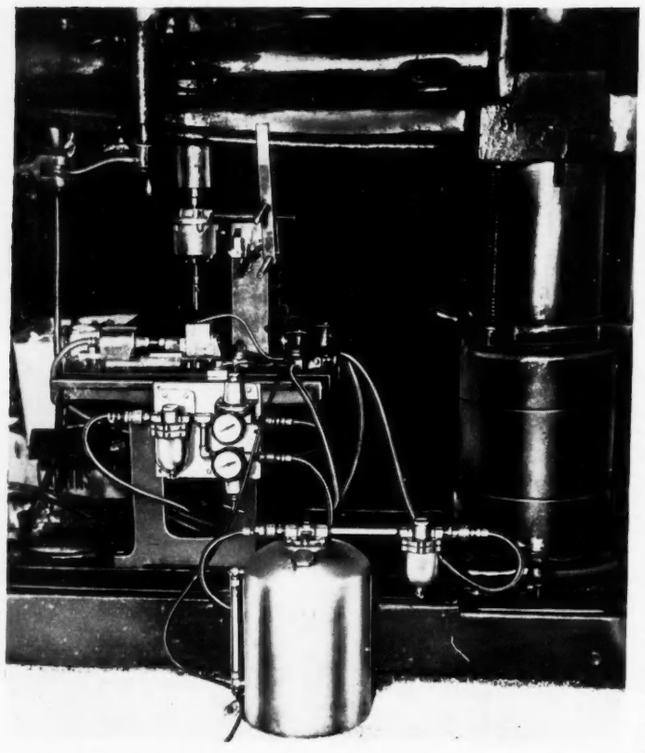


Fig. 2 In the Norgren Spray-Lube system, a controllable oil spray in a compressed air jet is directed between the workpiece and the cutting tool. It is suitable for multiple-spindle machines.

broaching oil, a chlorinated fatty mineral oil specially developed for the high-temperature high-nickel alloys and stainless steels employed in gas-turbine components has, it is claimed, in one instance stepped up the production of high-nickel components for turbojets from 19 to 870 parts per broach re-grind.

ASSESSING COOLANTS BY RADIO-ACTIVE CUTTING TOOLS

An important development in the cutting-coolant field is the establishment by Alexander Duckham and Company, Limited, of a radio-active machinability laboratory, see Fig. 1, which will expedite greatly the evaluation of cutting fluids in relation to cutting-tool wear. The principle consists in using radioactive cutting tools and measuring the radioactivity of the chips—and hence the tool wear—produced during the cutting operation; it has been established that 95 per cent. of the tool-wear products are embedded in the chips.

The cutting operation takes place on a Swift 8V3 lathe with a spindle speed range from 20 r.p.m. to 1,500 r.p.m., driven by a 15 h.p. motor. The cutting chamber, of steel 1 in. thick, completely enclosed to protect the operator from radiation, and is equipped withtits own cutting-fluid circulation system which supplies fluid for two jets, one on each side of the tool. In the base of the chamber is a small perforated container in which the chips are collected. Subsequently, after washing, drying and weighing, the chips are exposed to a scintillation counter and their radioactivity is recorded on a scaling unit. From this record the total wear per unit weight of chips can be calculated.

OILMIST, CO_2, AND HI-JET

Complementary to the development of the cutting fluids themselves is the method of applying them. While the traditional overhead method of application has given beneficial results at low cutting speeds, it becomes less satisfactory at the higher speeds which are being increasingly adopted, and methods have been sought both for increasing the rate of heat transfer from the cutting tool and for more effectively reducing friction between the cutting edge and the work.

The oil-mist method of lubrication, in which a spray of atomised lubricant in compressed air is directed between the workpiece and the cutting tool, is gaining favour both for "difficult" applications and where high rates of metal removal are involved as, for instance, in the heavy-duty routers described in the article on "Machining Light Alloys" in the June 29 issue of ENGINEERING. The makers of these machines recommend the use of "suds mist" lubrication in place of the conventional suds pumps used on their earlier machines.

Among the pioneers of oil-mist lubrication, C. A. Norgren Limited, Shipston-on-Stour, Warwickshire, displayed at the Machine Tool Exhibition their Mistcool equipment, introduced a year or two ago, and their new development, Spray-Lube. The Mistcool system, which is primarily suitable for single-point machine tools, is made up from the company's standard units designed for pneumatic-tool and cylinder lubrication systems, and comprises an air filter, a pressure unit and a lubricating unit. Three versions are available—No. 1, for soluble cutting oil, with an Oil Fog lubricator; and Nos. 2 and 3 for neat oils, with Micro-Fog lubricators, the one fitted on the No. 3 unit providing a finer control over the amount of oil.

The Spray-Lube system, see Fig. 2, has been introduced for a wider range of metal-cutting and forming operations, and is suitable for use with multiple-spindle machines. It also provides for controlling the type of spray directed on the tool. The compressed air supply, after passing through a filter, divides and flows through two pressure regulators, one controlling the air line to a mixing valve and the other serving to regulate the pressure on a reservoir containing the cutting fluid, which may be either of the neat or soluble-oil type. From the reservoir, the fluid is fed by air pressure to an adjustable mixing valve where it mixes with the air and is delivered from the nozzle in a coarse or fine spray, depending on the relative adjustment of the air and liquid pressure regulators.

Equipment for oil-mist lubrication is simple and both the first cost and running costs are low, since only a small quantity of oil is required. At high cutting speeds, oil-mist lubrication is cleaner in operation and users' experience, both in industry and in a machining research laboratory working on the cutting of Nimonic and other high-temperature alloys, has indicated that tool life can be at least doubled by the use of oil-mist equipment.

Two other rather more complicated systems (not on view at Olympia) which promise even more effective increases in tool life when machining "difficult" materials—probably of the order of ten times the life obtainable with overhead fluid application—are the Ce De Cut coolant system of applying a jet of carbon dioxide snow towards the tool tip, developed by the Carbon Dioxide Company, Limited, in collaboration with the Central Research Department of the Distillers Company, Limited, Great Burgh, Surrey (described in the January 29, 1954, issue of ENGINEERING, page 156, vol. 177); and the Hi-Jet system of the Gulf Oil Corporation, now being developed in the United Kingdom by Gulf Oil (Great Britain), Limited, 6 Grosvenor-place, London, S.W.1—soon to be available commercially.

Whereas in the Ce De Cut system the carbon dioxide jet acts purely as a cooling medium, the Hi-Jet oil-jet system is said to provide lubrication between the cutting edge and the work, reducing friction and allowing heat to be transferred directly from the cutting edge to the oil. In the Hi-Jet system the cutting fluid is directed between the workpiece and the tool, but in this case in the form of an oil jet under a pressure of about 400 lb. per sq. in.

Evidence that the oil jet penetrates to the cutting zone is provided by the vapour generated during the cutting process; this vapour is contained within an oil curtain surrounding the cutting zone.

The makers of Hi-Jet equipment state that it will increase the life of high-speed steel tools by six to twelve times, and laboratory machining tests by an independent authority using high-speed steel tools on a 60 ton nickel-chromium steel indicate that these claims are justified. Although the manufacturers recommend the use of Hi-Jet oil with their equipment, it seems likely that the Hi-Jet system can be used advantageously with a variety of cutting fluids.

SLIDEWAY LUBRICANTS

Although this article does not set out to cover machine-tool lubricants in general, we should like to refer briefly to the problem of lubricating slideways.

The increase in size and weight of grinding, boring and milling machines and the demands for greater accuracy of machining have shown the need for improved tableway lubricants. To overcome the "stick-slip" problems often encountered on such machines, the Shell Tonna range of oils (300 to 2,600 sec. Redwood No. 1 viscosity at 70 deg. F.) have been developed, with the requisite characteristic that their static

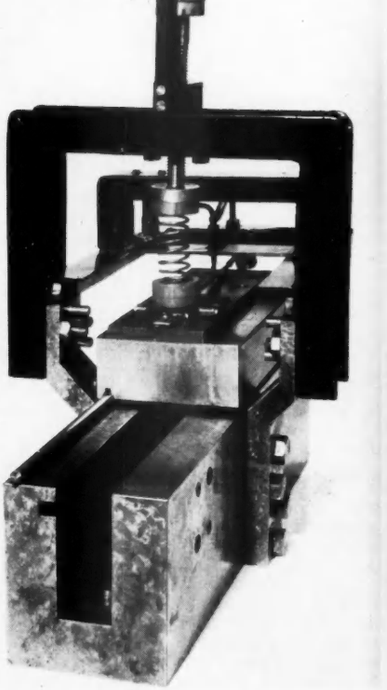


Fig. 3 The measuring head of modified Bowden friction machine on which the "stick-slip" characteristics of tableway lubricants were assessed by Shell-Mex and B.P. Ltd.

coefficient of friction remains less than the kinetic coefficient of friction over their operating speed range. They also contain non-drip, anti-wear and oiliness additives and are suitable for use in machine-tool hydraulic systems. One of the features of the exhibits of Shell-Mex and B.P. Limited, illustrated in Fig. 3, and shown at the International Machine Tool Exhibition was the measuring head of a modified Bowden friction machine, on which the anti-friction properties of the Tonna oils had been developed.

Other recently-developed slideway lubricants include Alexander Duckham's Q.5031, a non-corrosive extreme-pressure lubricant developed to meet Cincinnati Specification P.47; and certain of the range of Magna machine-tool lubricants supplied by Wakefield-Dick Industrial Oils, Limited, are intended for lubricating slideways subjected to high specific loadings at low speeds of operation.

The Machine Tool Industry

FURNACES AND HEATERS

Though furnaces and heating devices may not strictly be called machine tools, they are employed by manufacturing industry much as machine tools are used, and they were in fact well represented at the International Machine Tool Exhibition. Following this example we are including them in the present series of articles.

During the past four years, the changes which have taken place in tool and component heat-treatment furnaces have largely been in the nature of improvements in detail. Most of the processes employed have been established for a long period and while workshop techniques rarely, if ever, remain static over a span of years, it may be said that few spectacular advances have taken place in this field since 1952.

Thus, induction heating was already well known and in current use when the last International Machine Tool Exhibition was held, but in recent years the process has been made more adaptable and its applications have been considerably widened.

INDUCTION HEAT-TREATMENT PLANT

This is exemplified by a general-purpose induction-hardening machine demonstrated for the first time on the stand of Birlec Limited, Tyburn-road, Birmingham, 24. The machine is shown in Fig. 1 and permits induction heating to be applied to varied batches of work as opposed to long continuous runs of selected repetition parts, by allowing rapid, simple interchanges of inductor coils and work fixtures to be made. On the stand the machine was powered by a 15 kW motor alternator made for Birlec Limited by the British Thomson-Houston Company, Limited, and normally employed for general-purpose work.

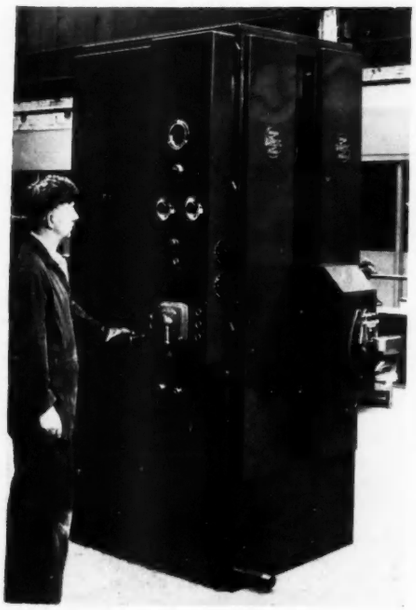


Fig. 1 High-frequency induction vertical hardening unit for general-purpose work. A quick-acting contact attachment allows various types and shapes of heat-inductor coils to be interchanged immediately without tools. (Birlec Ltd.)

Directly in front of the machine stands a substantial vertical four-sided rotatable work-support head which can carry four different work-holders and bring any one of them into action instantly. A quick-acting contact attachment permits the heating inductor coils to be changed immediately, without tools. The inductor coils, one of which is shown being fitted into the heating head of the machine in Fig. 2, are fabricated from solid high-conductivity copper, but simple heating coils made from tubing can be used for trials or experimental runs. The heater parts may be quenched instantly *in situ* by multiple water jets incorporated in the inductor coil. Heating and quenching time cycles are easily set on appropriate dials and are then automatically controlled.

The vertical movement of the heating head facilitates quick positioning for localised heating or full traverse for progressive hardening, as desired. When considered necessary, provision is made for rotating the work piece during heating, to minimise the distortion of long parts. The rotatable work-support head standing in front of the machine can be removed if desired and other special fixtures substituted.

Another adaptable induction heater was to be seen on the stand of Radio Heaters, Limited, Wokingham, Berkshire. This is shown in Fig. 3. It is called the 6 kW Radyne C50 induction heater and is intended for soldering, brazing and heat-treatment operations. In front of the operator are the mains switch, the heat output meter and three tell-tale lamps. The heat "on-off" push buttons are plugged into a socket in the right side of the work-table. Alternative connections permit the heat to be controlled by means of a foot or a limit switch. The removal of the table top exposes a water quenching sink in which hardening jigs can be mounted. The quenching water can be turned on automatically at the end of the heating cycle. The heater stands on heavy rubber-mounted castors and is easily moved. Its weight is 600 lb.

Other firms showing induction heaters of various types included Delapena and Son, Limited, Zona Works, Cheltenham, and Wild-Barfield Electric Furnaces, Limited, Elecfurn Works, Watford By-Pass, Watford.

CARBONITRIDING FURNACE

Wild-Barfield also had on view a shaker-hearth furnace for the continuous carbonitriding of small components and a complete drip-feed gas-carburising installation using the "Carbodrip" system. The principles of this system were described on page 472 of our vol. 178 (1954). Briefly, the carbonitriding atmosphere consists of a carburising gas to which is added sufficient ammonia (usually in a concentration of from 2·5 per cent. upwards) to produce the desired carburised case. Atmospheres for drip feed are derived from suitable organic liquids such as mixtures of alcohols and hydrocarbons. The liquid is fed directly into the furnace where it vaporises and is circulated through the charge space by a fan. The drip-feed system is available with shaker hearth, rotary-drum and batch-type furnaces.

Fig. 2 Inserting an inductor coil into the heating head of the Birlec induction hardening unit.

Fig. 3 Radyne induction heater for soldering, brazing and heat-treatment, in which the heating current is controlled by a foot-operated switch.

An interesting example of the application of the Corrtherm heating element developed by the Electric Resistance Furnace Company, Limited, Netherby, 161 Queen's-road, Weybridge, Surrey, and their United States associates, the Lindberg Engineering Company, Chicago, was to be seen on the stand of the former company. The furnace was a controlled-atmosphere unit for gas carburising, carbonitriding, bright hardening and bright annealing, rated at 20 kVA and having a charge space 24 in. long by 12 in. wide by 10 in. high.

ELECTRIC RESISTANCE FURNACE

Corrtherm elements are sheets of corrugated nickel-chromium alloy which practically cover the entire walls of the furnace and, in some cases, are disposed also in the heating chamber between rows of work being treated. They are hung from alloy hooks extending through the roof thus greatly simplifying installation and replacement procedures. No supports or hangers need be built into the heating-chamber walls.

The corrugations give strength, greater length for greater resistance, and the corrugations can be spaced to vary the heat release along the length of the furnace to compensate for door heat losses or incoming cold work. The greater surface area of the elements results in lower surface temperature and therefore longer element life.

The Corrtherm element is stated to be unaffected by carburising gases. In gas-carburing furnaces, however, carbon deposition cannot be prevented, but it is pointed out that the voltage in the furnace is so low that leakage through such deposition is impossible. Actually, the oxide coating which forms on the surface of the element is sufficient to confine the current to the element even when this is covered with soot. Moreover, a high-temperature enamel is fired on to the element. It is also stated that, again on account of the low voltage, accidental contact with the element when loading or unloading the furnace cannot cause the operator any harm.

The Incandescent Heat Company Limited, Cornwall-road, Smethwick, Birmingham, were showing a twin-chamber preheated-air town-gas fired tool-hardening furnace. Primarily developed for the heat treatment of cutters and circular saws, a similar design of furnace has now been evolved for the treatment of ordinary tools arranged on refractory trays. The furnace atmospheres are capable of regulation to avoid decarburisation and temperatures of 850 deg. C. are obtainable in the preheating chamber and of between 1,100 deg. C. and 1,400 deg. C. in the high-temperature chamber. The furnace burners fire tangentially into the cylindrical high-temperature chamber and, after circulation, the waste gases pass beneath the hearth of the preheating chamber and circulate round it before being discharged through a preheater to the atmosphere. In the preheater the combustion air is heated to a temperature of 275 deg. C.

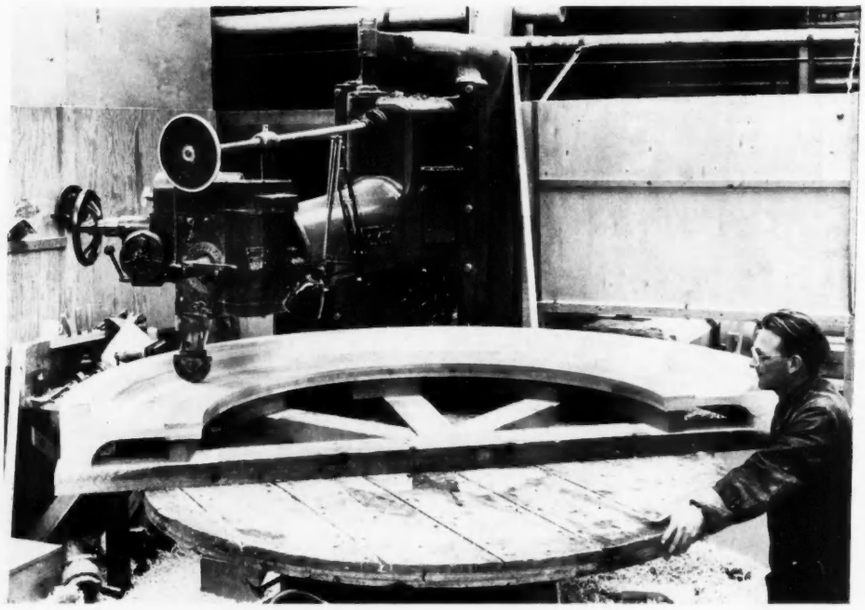


Fig. 1 Forming a half-blank pattern with the Wadkin pattern miller for a stone-breaker gear blank.

The Machine Tool Industry

WOODWORKING MACHINERY

Sawing, planing, moulding, mortising and sanding—these traditional processes remain the basis of woodworking machinery. Development has been mainly towards improving the accuracy and quality of the product by stiffening and strengthening the traditional machine tools; and towards increasing output by power-operated feeds and built-in electric motors, either directly spindle-mounted or driving through short V-belts, by increasing versatility in the range of operations, and by cutting down maintenance work through enclosing drive mechanisms and "cleaning up" the design.

TOOLS FOR THE PATTERN SHOP

Some of these trends were to be seen at the International Machine Tool Exhibition at Olympia in the exhibits of Wadkin Limited, Green Lane Works, Leicester, all of which were primarily of interest to the pattern shop, and included a hydraulically-operated cross-cut saw, a canting-spindle dimension saw, a 16 in. surfacer and a recessing machine. Nearly 60 years ago, the first machine built by the Wadkin company was a pattern miller with which, for the first time, engineers' patterns and core boxes could be produced by mechanical means. Basically, the same type of machine is still produced to-day, and can be seen in Fig. 1, above, but with a stiffer worktable and more substantial slides, and with improved drive. Originally, the spindle motor was housed at the inner end of the overhanging arm which carries the spindle head, and the drive to the spindle was taken through a shaft and gear train. In the current machine, the spindle motor is built into the cutting head and the drive is through a short V-belt. The more substantial machine of to-day can produce a limited range of non-ferrous metal patterns as well as wooden patterns in the most complex shapes.

The Wadkin 24 in. panel planing and thicknessing machine shown in Fig. 2, on the right, is an example of the trend towards cleaner lines and enclosed mechanism which prevents the ingress of chips and dirt. This machine is fitted with a four-knife circular block running at 4,500 r.p.m., with six feed speeds ranging from 20 ft. to 100 ft. per minute. A recent innovation is the built-in combined knife-grinder, cutter-setting and jointing mechanism which enables the cutters to be re-ground on the block without removing them from the machine; this arrangement enables the knives to be set with greater accuracy and allows the use of higher feed rates with an improved standard of finish.

One of the old-established woodworking firms in the United Kingdom, Thomas Robinson and Son, Limited, Railway Works, Rochdale, operate a complete saw-mill and woodworking machine shop as part of their flour-milling machinery manufacturing division. Thus they have an unusual opportunity for experimenting with woodworking machinery to satisfy the needs of modern production.

Recent additions to their range of machines designed for high-productivity include a 54 in. vertical band re-saw and an 18 in. tilting-spindle electrical dimension saw bench. The latter, illustrated in Fig. 3, is powered by a 7½ h.p. motor mounted directly on the spindle and is designed for ripping, cross-cutting, mitring and grooving to fine limits. The table, 44 in. by 40 in., has a 16 in. wide rolling front portion. The saw tilts up to 45 deg. and the spindle is adjustable vertically. A riving knife, carried from the saw frame, rises, falls, and tilts with the saw. A quickly adjustable tilting and swivelling fence and a graduated mitring fence are standard fitments, and a double mitring fence is available as an extra.

The vertical band re-saw shown in Fig. 4, designed for high-speed gauge or centre sawing, bevel sawing and box-board production, has a six-speed gearbox giving speeds from 30 ft. to 180 ft. per minute and is provided with a four-roller self-centring feed gear. The feed rollers are arranged to tilt up to 10 deg. for bevel sawing, and the top saw wheel has a powered rise and fall. A saw straining device is incorporated which prevents the machine from being started if the saw is incorrectly strained.

SHAPING AND PLANING

The output of spindle-moulding machinery has been stepped up by the introduction of automatic feeding, as in the automatic spindle shaper made by Thomas White and Sons, Limited, Paisley, Scotland, and illustrated in Fig. 5, on the facing page. At Olympia, a more recent version—the double spindle shaper—was on view. In this machine the operator is engaged in loading one worktable while on the other table the workpiece is automatically fed past the rotating cutter by a power-operated jig feed. The workpiece is mounted on a jig around which is attached a sprocket chain. By means of a pneumatic ram, the jig template is held in contact with a guide collar on the cutter spindle, and the sprocket chain is engaged with a sprocket also mounted on the spindle. Thus, as the spindle rotates, the sprocket and chain drive carries the workpiece past the cutters, automatically forming the edge to the desired shape.

Fig. 2 Wadkin panel planer and thicknesser is equipped with a built-in combined knife grinder, cutting setter and jointing mechanism; this enhances knife-setting accuracy and enables higher feed rates to be used.

Fig. 3 Robinson electric dimension saw for ripping, cross-cutting, mitring and grooving to fine limits.

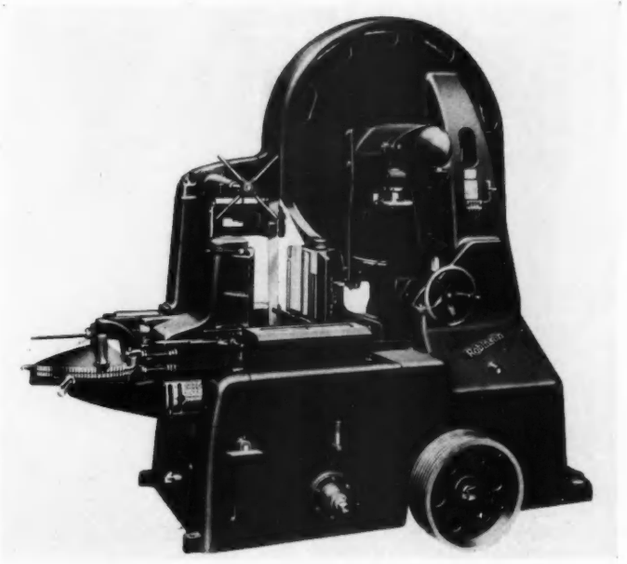


Fig. 4 Robinson 54 in. vertical band saw for high-speed gauge or centre sawing, bevel sawing and box-wood production.

Fig. 5 (left) In White's automatic spindle shaper, the workpiece is automatically fed past the cutter by a chain and sprocket drive, guided by a pneumatically-loaded template.

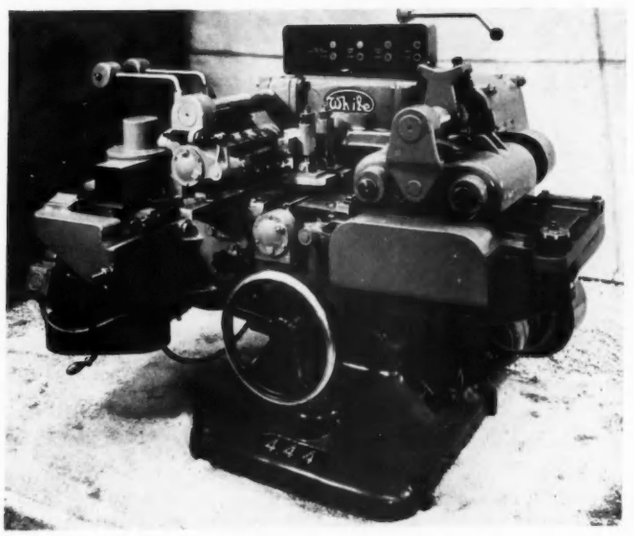


Fig. 6 (right) The White 12 in. by 4 in. planing and moulding machine has fixed top feed rollers and top cutter head, with a vertically adjustable table carrying the bottom feed rolls, the bottom cutter head and the two vertical cutters.

In the 12 in. by 4 in. planing and moulding machine type 444, shown in Fig. 6, introduced recently by Thomas White and Sons, Limited, all the cutter spindles are driven by short endless belts from built-in motors. In contrast to conventional planing and moulding machines, in which the table is fixed and the cutter-heads are adjusted in relation to the table, in the White machine the top feed rollers, the top cutter-head and top pressure are fixed, and the table—on which are mounted the bottom feed rolls, the bottom cutter-head and the two vertical cutter-heads—is adjustable vertically. A multiple-plate clutch in the feed drive ensures smooth starting and instant stopping of the feed, which has an infinitely variable speed range from 30 ft. to 80 ft. per minute by means of an expanding pulley-belt drive.

For use with their planing and moulding machines, Thomas Robinson have recently introduced a self-contained top throating head unit to facilitate such work as the throating of sills and the production of underhead moulds. The cutter spindle, mounted on ball bearings, is driven by a built-in 1¾ h.p. 3,000 r.p.m. synchronous motor. The complete cutterhead is carried from a horizontal slide and may be moved across the table by a lead screw. A vertical screw adjustment is also provided, and the spindle can be fitted up to 30 deg. either side of the vertical. Either a small cutter block or a saw can be used.

HYDRAULIC FEEDS

The application of hydraulics to increasing versatility is seen in the Trufeed straight-line edger type SJB shown at the Exhibition by Thomas White and Sons, Limited, which incorporates an infinitely variable feed ranging from 0 to 200 ft. per minute, enabling the operator to select the optimum speed for a particular job. The Trufeed machine is illustrated in Fig. 8. A Carter self-contained hydraulic pump and motor is used to drive the feed chain. The saw, driven by a built-in motor, is mounted above the table. The shortest length of stock which may be fed is 9 in., and the machine will accept work 4¼ in. deep and 30 in. from column to saw.

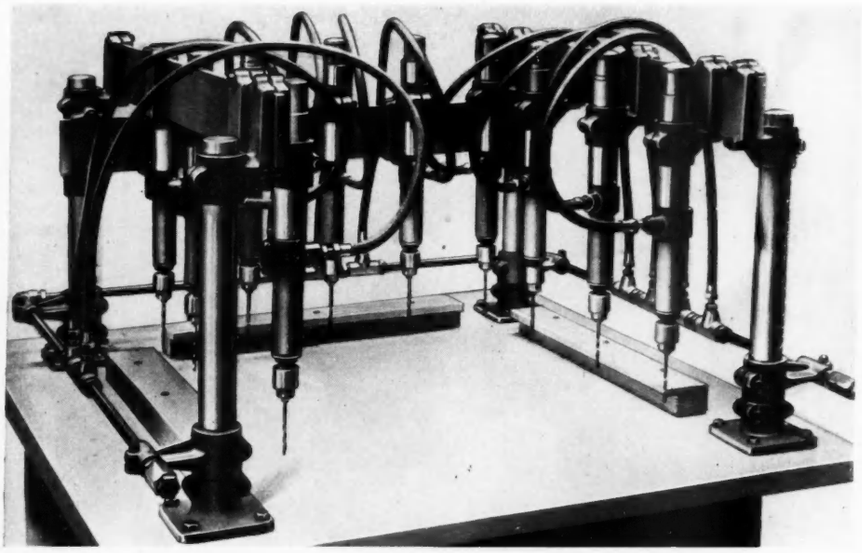
The policy of R. S. Brookman Limited, Parkside Works, Rothley, Leicestershire, is to concentrate on a few special-purpose machines designed for high productivity. They were among the first to apply the modern hydraulic system of toolhead movement to woodworking machines.

Their Hydraulectric morticer is claimed to be four times as fast as the more orthodox hand-lever type. The tool head has fast idle movements with controlled cutting speeds. Cramping is automatic. The operation is controlled (*a*) by a foot pedal which gives absolute control, the head following each movement of the pedal; (*b*) by a light foot switch which gives automatic tool reciprocation; and (*c*) by a worktable switch, when the machine is caused to work completely automatically by the simple action of placing the work in position on the worktable. The advantage of the hydraulic system is that a very high rate of output is obtained while retaining complete and simple versatility.

SELF-FEED DRILLING

Another interesting Brookman development is the self-feed multiple drilling system, illustrated in Fig. 7, designed as a simple and reasonably priced method of drilling the multiplicity of screw holes which occur in woodworking production. Its success was such that it is now also in demand for plastics and light-alloy drilling. For the greater measure of feed control required for these applications, Brookman have recently introduced a feed-speed controller giving an infinitely variable rate from zero up to 1 in. per second.

The self-feed multiple drilling system consists



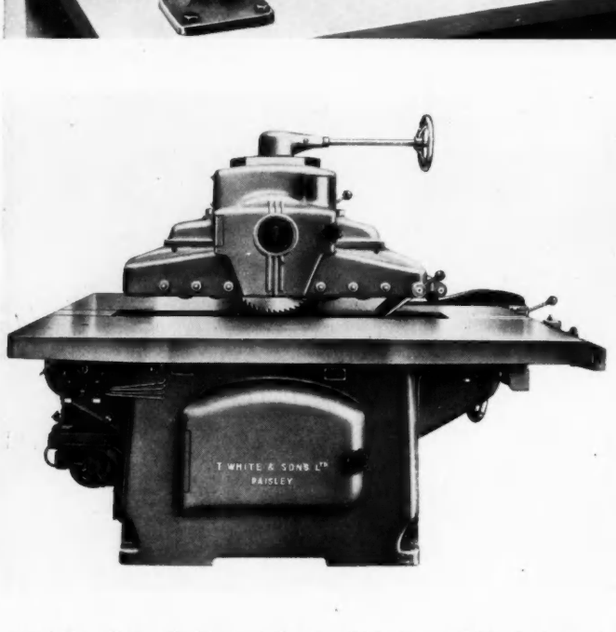


Fig. 7 The Brookman self-feed multiple drilling system can now be adapted for work on plastics and light alloys by a feed-speed controller which provides the higher degree of feed control necessary for these applications.

Fig. 8 (left) The White Trufeed straight-line edger has an infinitely variable hydraulic feed ranging from 0 to 200 ft. per minute.

essentially of an air-driven drill to which is attached an extension housing and air-operated feed mechanism. Only one air connection is required to each drill, the feed and retraction being automatic, with the drill running the whole time, when the air is switched on. To support these drills in the requisite positions, a full range of clips, cross-bars and support columns is available. By selecting from these, almost any pattern of drilling can be arranged over as wide an area as desired. The maximum drill size is limited to ¼ in. diameter and the minimum adjacent drill centres is 2 in. The drills can be mounted to operate vertically or horizontally, and the clip system enables any angle combination to be achieved.

DRUM SANDER

A typical example of modern drum-sanding equipment was shown at Olympia by Thomas White & Sons, Limited—their double drum sander type BDB which has been introduced recently to serve the needs of smaller woodworking firms. As in their larger versions, in this machine the abrasive paper is spirally wound on to the drums and is automatically tensioned. The drums, which are each driven by independent built-in motors, oscillate axially as they rotate. Work is fed in on a conveyor, the bed of which is mounted on knife edges, and the platens against which the work is held are ground to ensure accuracy. Infinitely variable feed speeds between 14 ft. and 35 ft. per minute are provided and are indicated on a tachometer. The exhaust hood can be swung clear on hinges to give access for changing the paper.

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CHEMICAL CLEANING PROCESS FOR FERROUS CASTINGS

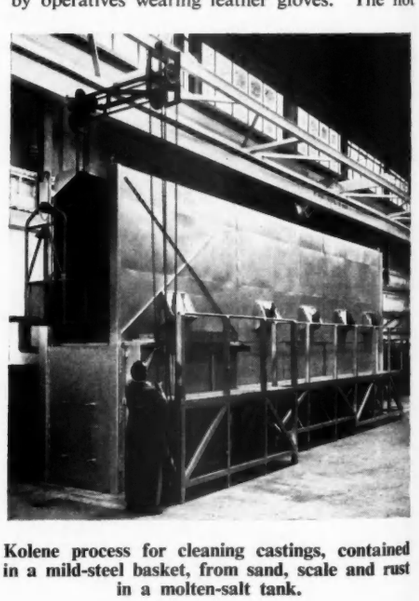
A cleaning treatment, termed the Kolene process, for the removal of core sand, foundry scale, rust, silica and other matter from intricate ferrous castings, for preparing the surface of castings or forgings for brazing, silver soldering or tinning, and for other applications of a somewhat similar nature, has been introduced into this country by Castingite Limited, Stone Yard, Deritend, Birmingham, 12. This firm, which is a subsidiary company of Birfield Industries Limited, 37 Portman-square, London, W.1, has acquired from the Kolene Corporation, of Detroit, Michigan, U.S.A., the sole rights in the British Isles for operating the process, selling the plants in which it is conducted, and supplying the requisite salts. Briefly, the Kolene process consists in immersing the castings to be treated in a bath of molten salts, in which the cleaning is accomplished electro-chemically.

A plant for demonstrating the process and for undertaking jobbing work has been erected at the Castingite Works in Birmingham, and this is shown in the accompanying illustration. It has a capacity for dealing with about 1 ton of castings an hour and consists of a treatment tank, a cold-water rinsing tank and a hot-water rinsing tank, the whole enclosed by an adequately ventilated hood. The castings to be treated are placed in the mild-steel work basket shown suspended from the overhead travelling crane and when inside the hood, the end steel door is raised to close the opening. The basket is then lowered into the fused-salt cleaning bath immediately below, containing Kolene salt maintained at a temperature of 450 deg. C. by electric heaters. The salts comprise a hygroscopic alkali base with neutral salts which are stated to act catalytically when activated electrically. The salts are completely water-soluble and are therefore easily washed off the castings at the end of the operation.

CONTROLLED REACTIONS

The chemical reactions in the bath are produced and controlled electrically, the electrical energy for activating the bath consisting of a 6 to 8 volt direct current of 3,000 amperes, which is produced by suitable rectifiers. One lead from the direct current source is connected to the mild-steel tank containing the Kolene salt and the other is connected to the work basket. The work may be made either negative or positive. When the process is used solely for cleaning, the reduction cycle, in which the work is made negative, is used. When it is intended to prepare work for tinning, the oxidation cycle, in which the work is made positive, is employed. The change from one cycle to the other is easily done by means of a change-over switch, which may be operated while the work is in the salt bath.

The time that the work remains in the salt bath varies with the type of treatment carried out but, in the demonstration plant at Birmingham, this is usually about 20 minutes. The basket with its load is raised clear of the salt bath and immediately plunged into the adjoining cold-water rinsing tank where it remains for some three minutes. The final dip in the hot-water rinsing tank occupies about 10 minutes. The steel exit-end door is then lowered and the basket taken out of the plant and its load removed by operatives wearing leather gloves. The hot castings dry off quickly and their recesses and sockets are seen to be metallurgically clean.



Kolene process for cleaning castings, contained in a mild-steel basket, from sand, scale and rust in a molten-salt tank.

The Kolene process can also be used for paint stripping and for the de-scaling of stainless-steel strip and, for each, a special type of salt is used. Both these processes are at present the subject of further study by Castingite Limited.

ATOMIC REVIEW

Materials: Conference on reactor physics (irradiation effects, chemistry and metallurgy)—Uranium resources and supplies—Composition of uranium ores.

Conference on Reactor Physics

At the conference on "The Physics of Nuclear Reactors," held by the Institute of Physics in collaboration with the British Nuclear Energy Conference and reported in the previous issue of ENGINEERING, a number of lectures were presented which dealt with the part played by materials in reactor design.

IRRADIATION EFFECTS

Speaking on "The Effects of Irradiation on the Physical Properties of Solids," Dr. A. H. Cottrell, of the Atomic Energy Research Establishment, Harwell, observed that ionising radiations dissipated most of their energy in solids by ionising and exciting electrons. Severe radiation damage was produced in organic and ionic substances by this process, but in metals the flexibility of the free electron structure conferred substantial immunity to ionisation damage. Atoms in metals were displaced by collisions with fast particles and the point defects so created altered the electrical conductivity and other physical properties. These point defects interacted strongly with dislocations, with the result that the mechanical properties of metals were very sensitive at low temperatures to heavy-particle bombardment. In semi-conductors the displaced atoms could trap conduction electrons and so produce large changes in electrical properties. Very intense particle bombardment produced drastic effects. Some minerals became non-crystalline; uranium crystals changed their shape markedly; and rare-gas atoms created by transmutations within the material might cause disintegration in brittle crystals and swelling in ductile ones.

Another aspect of reactor materials technology was treated by Dr. R. Spence, of A.E.R.E., in his lecture "The Role of Chemistry in a Nuclear Energy Product." He said that the development of atomic energy had been unique from a chemical point of view, in that a whole series of new elements, the actinide series, had been produced, and some of these, such as neptunium, plutonium and americium, played a major role in the technology. Furthermore, many elements which were previously little known and of academic interest only, had assumed technical importance, as for example, ruthenium, zirconium and protactinium. The application of atomic energy could be divided into the following broad fields from the viewpoint of chemical technology: raw materials; production of fuel elements and other special reactor materials: reactor chemistry; chemical processing of irradiated materials; and the disposal and utilisation of radioactive wastes. Although the provision of materials and the processing of irradiated fuel elements were of great importance, the nuclear reactor itself had always been the centre of interest. The earlier forms of reactor did not in themselves present any very serious chemical problems. Newer forms of reactor, however, operated at high temperatures and frequently bore more resemblance to chemical or metallurgical plants than to mechanical apparatus. There appeared little doubt, therefore, that the chemist would be involved equally with the physicist, metallurgist and engineer in the future development of nuclear reactors for power production.

METALLURGY PROBLEMS

The problems of the reactor metallurgist were discussed by Mr. L. Rotherham, of the United Kingdom Atomic Energy Authority Industrial Group, Risley, in a lecture entitled "The Role of Metallurgy in a Nuclear Energy Project." The manufacture of fuels for nuclear reactors had, he said, required a new industry to be set up for the extraction of uranium, and other new metals would become increasingly important. New alloys, too, and higher quality material in conventional metals had been developed to protect the uranium from attack by the coolants used. This had been one of the acute problems of nuclear energy. A metallurgical problem peculiar to atomic energy was the discovery of materials which would withstand the effects of neutron irradiation. The effects on non-fissile materials were usually minor changes in physical properties, but on fissile material the effects were much more severe. At lower temperatures the anisotropic nature of uranium resulted in large dimensional changes which were being overcome by grain refinement techniques involving alloying and heat treatment. At high temperatures the gaseous fission products tended to expand and disrupt the material by mechanisms which were not yet fully undertsood, and for which cures were still being developed.

Daggafontein uranium extraction plant. In South Africa uranium is often found in association with gold.

Mining Uranium

Mr. G. Coke, chairman of the Rio Tinto group, has suggested that the total demand for uranium metal for power generation might rise in the course of 20 years to a figure of 10,000 tons per annum, though this would only apply to a period of construction when the demand would mainly represent initial fuel investment. Fuel replacement would account for only small quantities of uranium. Present requirements for military purposes are believed to exceed 10,000 tons a year, but this figure is expected to fall rapidly after 1962 as needs are satisfied. It has also been mooted that uranium may before long become available through normal market channels, but the decision of the United States Atomic Energy Commission to extend its purchasing programme, originally due to end on March 31, 1962, until December 31, 1966, and to fix the price of uranium oxide (U_3O_8) at 8 dols. a pound, suggests that this will not be yet.

CANADIAN DEPOSITS

In recent months Canadian plans for the mining and sale of uranium have figured widely in the news. For example, the U.K.A.E.A. has, with the consent of the Canadian Government, entered into negotiations with Eldorado Mining and Refining Limited for the delivery of a substantial quantity of uranium before March 31, 1962. This will represent a major contribution to the supplies of uranium required to meet programmes for which the Authority is responsible. A similar arrangement was reached with the Australian Government for the purchase of uranium oxide from Mary Kathleen Uranium Limited (Rio Tinto group) earlier this year (ENGINEERING, vol. 181, page 245, 1956). Detailed contract arrangements between the U.K.A.E.A., the Eldorado company and the individual Canadian mines will resemble those under which uranium has been supplied to the United States Atomic Energy Commission. The Rio Tinto group are also supplying capital for Canadian uranium-mining developments and under this programme Algom Uranium Mines are to commence work at Quirke Mine, Blind River, Ontario, in September, and at Nordic Mine before the end of the year. Each plant can handle 3,000 tons of ore a day. Gunnar Mines, which have arranged to supply their entire output to Eldorado Mining and Refining, Limited, are to increase capacity by 32 per cent. to 1,650 tons a day; this will take effect early next year. Canmet Explorations may also sell uranium to the Eldorado company; uranium oxide concentrates obtained from their Blind River site in quantities based on a mill capacity of 2,500 tons a day are to be delivered from April 1, 1957. The ore body is said to be in the region of 5 million tons, and the grading 2·2 lb. of uranium oxide per ton.

Another considerable uranium discovery has also been reported in north Saskatchewan in the area of Lake Higginson, 140 miles east of Uranium City. Mr. L. R. Jackson, president of the Anglo-Barrington mine of the Western Selection and Development Company, London, has referred to deposits totalling more than 200,000 tons containing over 2 lb. of the metal per ton of ore. The ore was discovered during diamond drilling operations. Another deposit has been found in Labrador by the British Newfoundland Corporation and Frobisher Limited of Toronto. It is understood that even on the most optimistic view of Canadian nuclear developments, Canada's uranium resources—situated largely in the Great Bear Lake, Lake Athabaska and Blind River areas—will far exceed her domestic needs for many years to come.

A recent report states that the gross value of Canadian uranium sales, when all the mines envisaged are in full production, will be in the region of 300 million dols. per annum. It has also been estimated that by the end of 1956 some 7,000 tons of ore should be mined and processed in Canada each day and by December, 1958, over 25,000 tons a day. The figure of 100 million tons has been suggested as the total ore deposit.

A uranium nugget weighing almost a ton and worth nearly £A 7,000 is said to have been found in an Australian mine on the South Alligator River. In New Zealand, too, deposits have been reported; these are situated in the lower Buller valley in South Island and are believed to be in suitable concentration for working. The three main Australian sites are the Mary Kathleen mine, the Rum Jungle area in the Northern Territory, and Uranium Hill, Southern Australia.

GOLD AND URANIUM

Canada and Australia are by no means the only sources of uranium in the Commonwealth. It has been known for some time, for example, that uranium is present in some gold ores mined in South Africa, and existing gold extraction plant at Orkney, near Klerksdorp, in the Western Transvaal has recently been extended so that uranium may also be recovered from the

residual slimes. The plant is operated by the Western Reefs Exploration and Development Company, Limited, and the additional installation has been financed by the South African Government, which takes over the uranium, but returns part of the sale receipts to the company. The accompanying illustration shows Daggafontein's uranium extraction plant, which like the Orkney plant is administered by the Anglo-American Corporation of South Africa, Limited. The South African deposits are, as might be expected, some of the most important in the world and since 1952, when West Rand Consolidated Mines Limited brought into operation the first South African uranium plant, output has increased steadily. Now there are some 28 gold mines on the Rand with contracts to produce uranium and at least 20 are already supplying it.

In the Copperbelt of Rhodesia uranium is again found in association with another metal already being mined, in this case copper, and an experimental extraction plant is being built at Nkana, where the Mindola shaft of the Rokhana Corporation (Anglo-American group) is situated. Considerable prospecting is being carried out in both Northern and Southern Rhodesia—the Central African Exploration and Mining Company, for example, have locations in the Gatooma and Sinoia areas—and though no major deposit has so far been located, commercially workable ores are believed to exist. With this in mind the United Kingdom Atomic Energy Authority have established an office in Salisbury, Southern Rhodesia. It is worth noting that Northern Rhodesia touches the frontier of the Belgian Congo not far from the rich Shinkolobwe uranium deposits.

Apart from those in the Commonwealth, deposits have recently been discovered in Chile (Atacama), Greenland (Tunugdliarfik Fjord, Skovfjord and Kagssiarssuak near Narssasswak), Italy (Piedmont), Japan (Kawakima, Okuyama district), and Portugal (Beira Alta). Deposits known for some time also exist at Billingen in Sweden, in the Massif Centrale of France and in the Erzgebirge of Eastern Germany.

UNITED STATES RESOURCES

Although no new deposits have recently been announced by the United States authorities, output has increased considerably since 1948. Mr. J. C. Johnson, Director of the Raw Materials Division, U.S. Atomic Energy Commission, stated at the end of last month that the United States is producing uranium ore at a current annual rate of nearly three million tons, which compares very favourably with the figure of 70,000 tons mined in 1948. On the completion of projects now under way, he said the annual output of the free nations should be in excess of 30,000 tons of uranium metal. Known ore reserves had increased since 1948 from about one million tons to over 30 million tons. Domestic production would probably provide a large part of the U.S. uranium supply during the next five years, but subsequently new developments, both in overseas ore production and internal requirements, might change the position. The main United States deposits are in Colorado and in the Boulder area.

Little is known about Soviet resources, but deposits are believed to exist near Tashkent in Uzbekistan, and also in Kazakhstan, Turkmenia, Karelia and on the shores of Lake Baikal. There are also thought to be uranium fields in Sinkiang in China, in Rumania, in Hungary in the Velence and Mecsek mountains near Pecs, and in Bulgaria at Buhovo near Sofia. A mine has recently been opened at Klodzko, Lower Silesia, and there can be little doubt that the Soviet Union also imports large quantities of uranium from the mines of the Erzgebirge.

Uranium Minerals

Some 150 minerals contain uranium, but only two-thirds of these include it as an important constituent. Some of the more important ores are listed here: uraninite and pitchblende [UO_2]; brannerite [$(U, Y, Ca, Fe, Th)_3Ti_5O_{16}$]; coffinite [$U(SiO_4)_{(1-n)}(OH_4)_n$]; tyuyamunite [$Ca(UO_2)_2(VO_4)_2 9H_2O$] (named after the Tyuya-Muyun mountains in the Soviet Union); autunite [$Ca(UO_2)_2(PO_4)_2 12H_2O$]; uranophane [$Ca(UO_2)_2 Si_2O_7 6H_2O$]; davidite [essentially $(Fe, Ce, U)(Ti, Fe)_3(O, OH)_7$]; carnotite [$K_2(UO_2)_2(VO_4)_2 nH_2O$]; and torbernite [$Cu(UO_2)_2(PO_4)_2 12 H_2O$]. Low-grade ores, including the phosphorite deposits of Morocco, the U.S.A. and the U.S.S.R., and marine shales, such as the Swedish alum shales, contain uranium as the oxide U_3O_8.

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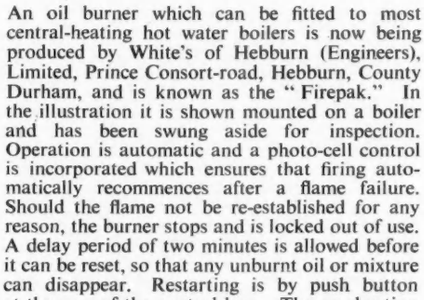
OIL BURNER

Lightweight Domestic Unit

An oil burner which can be fitted to most central-heating hot water boilers is now being produced by White's of Hebburn (Engineers), Limited, Prince Consort-road, Hebburn, County Durham, and is known as the "Firepak." In the illustration it is shown mounted on a boiler and has been swung aside for inspection. Operation is automatic and a photo-cell control is incorporated which ensures that firing automatically recommences after a flame failure. Should the flame not be re-established for any reason, the burner stops and is locked out of use. A delay period of two minutes is allowed before it can be reset, so that any unburnt oil or mixture can disappear. Restarting is by push button at the rear of the control box. The combustion head has been designed to give a fine atomisation and the mixture gives a large soft flame; a cut-off valve is incorporated in the head to prevent any



The Firepak oil burner is automatic in operation and can be fitted on the fire door of most boilers.

oil drip. The normal thermostat control can be supplemented by a time switch if required. The pump on the burner has a capacity up to 20 gallons per hour, and a safety valve regulates the oil feed, returning the surplus oil to the storage tank or to the inlet side of the pump. There is also a regulator on the impeller which supplies the air. The Firepak is being made in this country under licence from the Atelier des Charmilles S/A of Switzerland, and two models are available, one with a capacity of 108,000 to 271,000 B.Th.U. per hour and the other from 180,000 to 540,000 B.Th.U. per hour. The smaller model has an average consumption from 0·66 to 1·65 gallons of gas-oil per hour and the larger from 1·1 to 3·3 gallons per hour.

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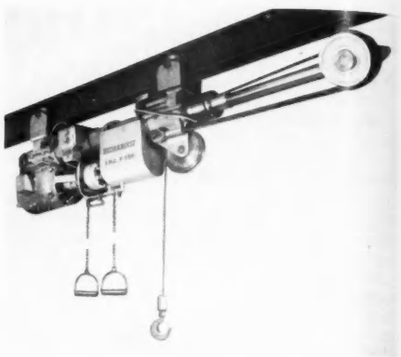
WIRE ROPE HOIST

Electro-Hydraulic Ram Action

The accompanying illustration shows an electro-hydraulic wire rope hoist, which is to be marketed under the name of Hydrahoist by Lifting Gear Products, 244 Earsham-street, Sheffield, 4. It consists essentially of a double-acting hydraulic ram which, when extended, operates through a series of oil-immersed pulleys. A wire rope,



Electro-hydraulic wire rope hoist containing no gearing and capable of infinitely variable speed regulation.

to which the usual hook is attached, runs over these pulleys, thus enabling the load to be raised or lowered.

Power for actuating the ram is obtained from an electrically-driven pump, which draws oil from a reservoir and forces it under pressure through a four-way piston-type control valve (which incorporates its own relief valve) to one or other side of the piston so that the hook is raised or lowered. The initial movement of the control handle switches on the motor, while subsequent movement gradually opens the control valve, thus enabling oil to pass to the ram cylinder. The control of speed is infinitely variable between the creep and maximum values.

When the ram is fully extended or contracted, that is with the hook in its uppermost or lowest position, the oil pressure is by-passed through the relief valve. By-passing through this valve also occurs if the hoist is overloaded, thus preventing any damage to the mechanism or the motor. The load is sustained by a positive hydraulic lock so that brakes are not required and it cannot slip in the event of pipe breakage.

These hoists are supplied with either a fixed suspension, push travel, geared travel or power travel. In the latter case a second hydraulic motor is provided for driving the trolley wheels, power for this purpose being obtained from the same pump and motor as that used for hoisting; the speed also being infinitely variable by means of a control valve.

The standard lifting speed of a one-ton Hydrahoist unit is 33 ft. per minute and that of a two-ton unit either 15 ft. or 34 ft. per minute. Higher speeds can, however, be obtained by fitting larger size pumps. The standard height of lift, that is, the distance between the hook in its highest and lowest positions, is 12 ft., but units with lifts from 8 ft. to 20 ft. can be supplied.

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ELECTRICALLY OPERATED IMPACT WRENCH

The Consolidated Pneumatic Tool Company, Limited, 232 Dawes-road, London, S.W.6, have introduced an electrically operated impact wrench which, has a ½ in. square drive. It will take a full range of sockets for hexagon and square nuts between ⅜ in. and ⅝ in. in diameter. Its profile has been specially designed so that it can be used in narrow spaces, while an angle head attachment is available which enables it to be employed in difficult positions.

Owing to its rotary-impacting action another application of the tool is for operating stud-drivers, sleeve and gear pullers and extractors for taps, dies and screws. A full range of screw-driver attachments is also available as well as others for socket adaptors, universal joints and ½ in. square drive extension bars.

The standard tool is wound to operate on either alternating or direct current at 230/250 volts. Its action being reversible it can also be used for backing off nuts.

In Parliament

SHIP ORDERS FROM RUSSIA

In the House of Commons last week Mr. C. Osborne (Conservative) brought forward the question of Britain building ships for Russia. He asked how many vessels were at present being constructed in this country as a result of the orders negotiated by Mr. Kabanov, the Soviet Minister of Foreign Trade, in 1954, when no fewer than 126 ships, of an estimated value of £120 millions, were listed as being required. As many of those ships were not on the strategic list, Mr. Osborne inquired also as to what steps were being taken to encourage British shipbuilders to undertake these Soviet orders in the interest of this country's export trade.

Mr. S. Wingfield Digby, the Civil Lord of the Admiralty, stated that Mr. Kabanov had not negotiated orders for ships, but had only presented a list of vessels in which his Government were interested. Some British shipbuilding firms would be glad to build certain types of vessels and were still in touch with the authorities in Moscow, but the Russian Government had not so far placed orders. On this side, the attention of the shipbuilding industry had been drawn to the advantages of negotiating for Russian orders.

INDUSTRIAL ACCIDENT PREVENTION

A series of questions was asked by Mr. F. Elwyn Jones (Labour) on the subject of industrial accidents and their prevention. He was assured by Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour and National Service, that the factory inspectorate was sufficiently manned to enable the inspectors to make periodic thorough inspections of all workplaces. All factories were thoroughly inspected from time to time but the intervals between the visits varied according to circumstances.

The Minister said he felt sure that the fact that information and advice on industrial accident prevention could be obtained by all concerned, whether at works levels or at area levels, from the district inspectors was already well known. Similarly, at the national level, industry could secure the assistance of the Chief Inspector of Factories. The recent report of the industrial safety sub-committee of the National Joint Advisory Council, which had received wide publicity, would make these points even better understood. A standing safety sub-committee of the Council had now been appointed and, in considering what further progress could be made, this body would look carefully at all aspects of public relations. The recommendations in the report called for preventive action by employers and workpeople, their organisations, education authorities, and the Ministry of Labour. The report had had an extensive sale and that, the Minister considered, augured well for its recommendations being given serious attention.

ECONOMIES AT THE D.S.I.R.

Details of the economies which it was proposed to effect on the approved estimate for the Department of Scientific and Industrial Research for 1956-57 were sought by Mr. A. Blenkinsop (Labour). He was informed by Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works, acting on behalf of the Lord President of the Council, that, according to a statement by the Chancellor of the Exchequer on June 26 last, the reduction to be made in the published estimate of the Department would amount to £150,000 in the financial year referred to. Economies would be effected by reducing staff costs by £33,000, by slowing down the rate of recruitment; by reducing grants for industrial research by £20,000; by lowering the capital and general expenses of the Department's establishments by £49,000, mainly by economising in the purchases of equipment and consumable stores; and by limiting expenditure on extra-departmental research by £20,000. The last-mentioned reduction would be obtained by delaying the commencement of a new borehole for the Geological Survey. The Department's net estimate would also be reduced by £70,000, as a result of increases in test fees and similar charges.

Mr. Bevins pointed out that the savings detailed above would amount to £192,000, and added that an increase in expenditure of £42,000 on scientific grants must be offset against that total, thereby giving the net sum of £150,000, as announced by the Chancellor. Of the £42,000 mentioned, £37,000 would be spent on research connected with nuclear physics and £5,000 for grants in other directions.

Distribution of Individual Net Incomes

The Chancellor of the Exchequer, Mr. Harold Macmillan, told Mr. W. W. Hamilton (Labour) that it was estimated that approximately 8,100,000 persons had a net annual income of less than £250, after the deduction of tax, in respect of last year. This group, the Chancellor said, consisted mainly of pensioners and juveniles. Also during 1955, some 8,700,000 persons received net annual incomes of between £250 and £499; about 6,500,000 people had net incomes of between £500 and £749; and a further 1,900,000 people net incomes of from £750 to £999. In addition, approximately one million persons had net annual incomes of £1,000 or over. The figures quoted referred to all incomes, whether from earnings or investments, as separate statistics for earned incomes were not available. Contributions for national insurance had been taken into account, but deductions for that purpose had been limited to that part of the contribution which qualified for income tax relief.

Miles 100 Jet Aircraft

Information as to the potentialities of the Miles 100 jet aircraft for training purposes in the Royal Air Force was sought by Mr. P. B. Lucas, D.F.C. (Conservative). He asked the Secretary of State for Air whether it was proposed ultimately to introduce that aircraft into service. In reply, Mr. Christopher Soames, the Under-Secretary of State, said that careful consideration had been given to the matter but it had been decided not to adopt the Miles 100 as a jet trainer for the R.A.F.

Advanced Technology in Bradford

Expenditure for the furtherance of education in advanced technology at Bradford Technical College was the subject of a question by Mr. George Craddock (Labour). He was informed by Sir David Eccles, the Minister of Education, that new buildings, costing about £400,000, for the Rosemount Technical Institute were included in the 1956-57 building programme and that it was hoped that these extensions would help to remove much of the lower-level work from the College. Approval had also been given, as part of the programme for 1957-58, to four minor projects costing about £90,000, and the Minister said that he would be considering, in due course, with the assistance of the local authority and the governing body of the College, whether further projects were needed to enable that establishment to fulfil the conditions required of a college of advanced technology.

Dilutees in Engineering

The position of dilutees in the engineering industry continues to attract attention. Mr. I. J. Pitman (Conservative) asked when the term "dilutee" first came to be applied officially to employees of the Air Ministry. The Secretary of State for Air, Mr. Nigel Birch, replied that the term was first used by his Department in October, 1939, when the "Temporary Relaxation of Existing Customs Agreement" was signed. It denotes an industrial employee who has not served an apprenticeship or had equivalent engineering experience, but who is, nevertheless, employed on skilled work.

On the following day, Mr. Iain Macleod, the Minister of Labour and National Service, told Mr. Pitman that he could not say when the term was first used but that the word "dilution," in its industrial meaning, was in common use as early as the First World War. The expression "dilutees" was used in certain relaxation of customs agreements in the engineering industry, dated 1940, to describe and identify workers who were introduced under those agreements to supplement the skilled manpower in the industry.

Oil Pollution from Ships

Mr. John Profumo, Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, informed Sir Harold Roper (Conservative) that, in a little over four years, no fewer than 188 cases of suspected discharge of oil by vessels at sea had been observed and reported by aircraft of the Royal Air Force and the Royal Navy. Most of these cases had been followed up with the Chamber of Shipping, or direct with the owners concerned. In the case of foreign ships, action had been taken through the International Chamber of Shipping.

Anglo-Australian Trade

Difficulties in the motor industry were referred to by Mr. Donald Chapman (Labour). He asked the Prime Minister whether, in the discussions now taking place, he would urge the Prime Minister of Australia to avoid further reductions in the import of British motor cars into Australia, as an aid to this country's export trade. Mr. R. A. Butler, the Lord Privy Seal, replying on behalf of Sir Anthony Eden, said that the discussions would cover all aspects of Britain's trade with Australia, including the effect of import restrictions there on British exports.

Transfer of the Imperial Institute

In reply to Mr. Austen Albu (Labour), Sir David Eccles, the Minister of Education, said that the Government hoped to be able to introduce the legislation required to transfer the functions of the Imperial Institute, South Kensington, from the present building to a new site, during the next session of Parliament.

Forth Road Bridge

Mr. J. Henderson Stewart, Joint Under-Secretary of State for Scotland, told Mr. W. W. Hamilton (Labour) that the Government intended to authorise a start on the new Forth road bridge within the first four years of the road-building programme announced in February, 1955. The precise date of starting would be decided upon in relation to the country's general economic circumstances. Consideration had to be given to the technical work involved and to the best way of financing the structure. As to the question of tolls, the Forth Road Bridge Order, 1947, provided for tolls to be levied.

Colombo Plan Technical Assistance

Figures showing how expenditure by the British Government, on account of the technical co-operation scheme of the Colombo Plan, has increased, since the establishment of the scheme in 1951, were given by Commander Allan Noble, the Under-Secretary of State for Commonwealth Relations. He informed Mr. W. N. Warbey (Labour) that, starting with £3,890 for the year 1950-51, expenditure had risen to £28,633 in the following year. For the next three twelve-monthly periods, the sums expended by Britain were £185,226, £371,537 and £584,828, respectively. Expenditure for the financial year 1955-56 was provisionally estimated at £662,803. Even after allowing for the reduction of the £80,000 announced by the Chancellor of the Exchequer, provision had been made for the expenditure of no less than £829,000 during the financial year 1956-57. Major T. Beamish (Conservative) made the point that the excellent progress being made under the Colombo Plan received all too little publicity from the member countries.

Commander Noble said that the proposed reduction would not affect those projects for technical assistance which had already been approved Applications for grants not yet approved would be considered in the light of the reduced provision, but the Government expected to be able to continue to meet all well-founded applications which they might receive.

THE HUMAN ELEMENT

Reduncancy may be due to competition—Possible further increases in steel prices—Applying heat to the price freeze—The philosophy of the ladder has dangers—General safeguard for retirement—The old order remains.

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Motor Vehicle Crisis Deepens

Last week-end's meeting of shop stewards from factories of all motor manufacturers passed a resolution demanding " that the executives of the trade unions call for a stoppage of work throughout the motor industry " and pledged their full support. Coming, as it did, after a number of abortive strikes in the factories of the British Motor Corporation, the shop stewards' resolution has brought the problems of redundancy into their full national context. The management of B.M.C. likewise consider that the problem of redundancy is one which should be tackled nationally. At a meeting with union representatives they refused to meet a claim for compensation on behalf of the dismissed workers, on the grounds that the matter was being pressed by the unions with the employers' federation. B.M.C. considered that, in the circumstances, they could not take independent action. They went far, however, in recognising that the dismissals had been over-hasty and gave an undertaking that in all future lay-offs there would be full consultation with adequate notice.

Meanwhile, there have been other lay-offs among component makers which suggest that not only under-employed workers had been sacked by B.M.C. but that production has also been cut. Qualcast have introduced short time, as have Pressed Steel and Lockheed. Lucas, Smith's Motor Accessories, Dunlop, Rubery Owen and Ratcliff (Great Bridge) have either announced lay-offs or that they are reviewing their labour position. The only bright spot in a disturbing situation is that the Ford Motor Company are recruiting labour, and have offered jobs to 200 of the dismissed B.M.C. workers. This, perhaps, is sufficient to show that the redundancy problem in motor vehicles is not national, but one for individual companies unable to hold their own in competition.

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Steel Tempers in a Boom

It may be only a coincidence, but there is some evidence to suggest that the steel disputes in the United States and in this country has taken place just on the crest of a boom. In the United States, steel is expected to run into a quiet spell in the autumn and there is a sign here and there that the boom in the United Kingdom may run itself out for some products before very long. Tempers have been allowed to get out of hand in the confidence of summer prosperity. The American steelmen are already on strike and the maintenance workers in this country may be out on July 14.

Unless the strike in the United States is of long duration, it is not likely to affect the United Kingdom steel position seriously. There is no doubt that the United States strike will prevent the export of steel abroad, and at one time this could have had a dangerous effect on the supply of steel in this country if a strike of maintenance workers came in the strip and sheet mills. At the moment, however, steel stocks are high in this country, and it had been expected that there would be a fall in imports from the United States in the autumn even if there had been no labour unrest in the two steel industries.

It is beginning to look in this country as if there is no way out of the impasse on the strike without raising steel prices. The dispute is about wage differentials for skilled men, and the employers are clearly sympathetic to the maintenance men's claims if they do not bring with them another demand for higher wages from other and less skilled steel workers. All this has happened before in printing and on the railways—and the way out has always been higher charges. Is steel heading for higher prices in a buyers' market ? It could happen both in the United States and here.

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Joint Pay Demand from Rail Unions

The Government's price " freeze " policy may bring about a closing of the ranks among railwaymen's unions which differences in outlook prevented last year. The annual conference of the National Union of Railwaymen produced some outspoken criticism of the Government's economic policy and angry complaints about the cost of living. Mr. J. Campbell, the general secretary, described the price freezing policies applied by the Government to the Transport Commission, the National Coal Board and the British Electricity Authority, as " shabby shifts of political ineptitude, fastening upon nationalised industries a halter which must ultimately react against their employees."

The conference instructed the executive to consult with the other railway unions to evolve a common wage policy " which will not only counter attacks upon our standard of living, but will also take into account increased production and efficiency on the railways which have not yet been reflected in railway wages." The arguments in favour of a wage demand were centred on the increase in the cost of living—a 2½ per cent. rise in the retail price index—since the last increase was granted. Mr. Campbell referred to last year's failure to get agreement between the three unions as " a very unfortunate experience " which could have had very serious effects on the wage application. There was a general feeling of optimism that this time agreement would be reached on a joint pay claim.

Here is thus one definite challenge to the Government's policy by the trade unions. The feeling of the conference was such that there can be little doubt of a joint claim being pressed. The Associated Society of Locomotive Engineers and Firemen announced last Saturday that they had submitted to the Commission the 15 per cent. wage claim decided upon at their annual conference earlier this summer. The inevitable rejection of this claim must lead to a closing of the ranks between the unions.

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Horner's Corner

Mr. Arthur Horner was brutally frank at the annual National Union of Mineworkers' conference last week that his union would not let the price freeze in coal get in the way of a higher wages demand. So far as he was concerned it was the board's worry to find the money to pay for an increase. Mr. Horner has cornered the labour market in a nationalised monopoly and he sees his strong bargaining position. His attitude found a quick echo in the demand of the A.S.L.E.F. for a 15 per cent. increase for footplate men on the railways.

From these two quick reactions on the side of labour to the price freeze it is clear that not only do some unions not take this price policy seriously, but that they propose to take the initiative in wrecking it. Their attitude is obviously " Pull up the ladder Jack (or should it be Arthur ?), I'm all right." Against this sort of raucous behaviour, the cultured, pleading tones of Sir Anthony Eden and Mr. Harold Macmillan sound like a request for a glass of milk in the public bar. For this kind of attitude there is only one brand of medicine likely to have any effect and that is a stern bout of deflation.

To trade unionists in the nationalised industries the more serious consequences of the present round of deflation may seem a long way off, but they may find that the industrial climate will veer sharply against them if the present economic trend continues. They may find that pressure to hold back wage demands comes from their own kind in other industries. If and when that time comes, the philosophy of the ladder may evoke bitterness among the ranks of organised labour.

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Pensions for Professional Engineers

The Engineers' Guild is to launch a pension scheme for professional engineers in the autumn. The object is to provide cover for the professional man throughout his career. The scheme is to be open to all members of the Guild and to other members of the Institutions of Civil, of Mechanical and of Electrical Engineers who are eligible to become members of the Guild. The Guild points out that it had been preparing a scheme of this sort for some time before the concessions on pensions for the self-employed were announced in the last Budget.

How far this scheme when published will offer attractions beyond those available under other group schemes remains to be seen. Two basic issues are apparent at this stage. If the terms offered are attractive and the scheme is well supported in consequence, as it will deserve to be, the Guild will have built a bridge in its own right between the professional institutions—an object it has had in mind for some time and which has not been easy so far to accomplish. Another point is this. If this move is successful it will draw the attention of engineers, especially those engaged in professional work, to the possibilities of using insurance arrangements and annuity devices as a means of perpetuating partnerships on terms attractive to the younger men who need security, and who these days often do not have capital to buy their way into an organisation.

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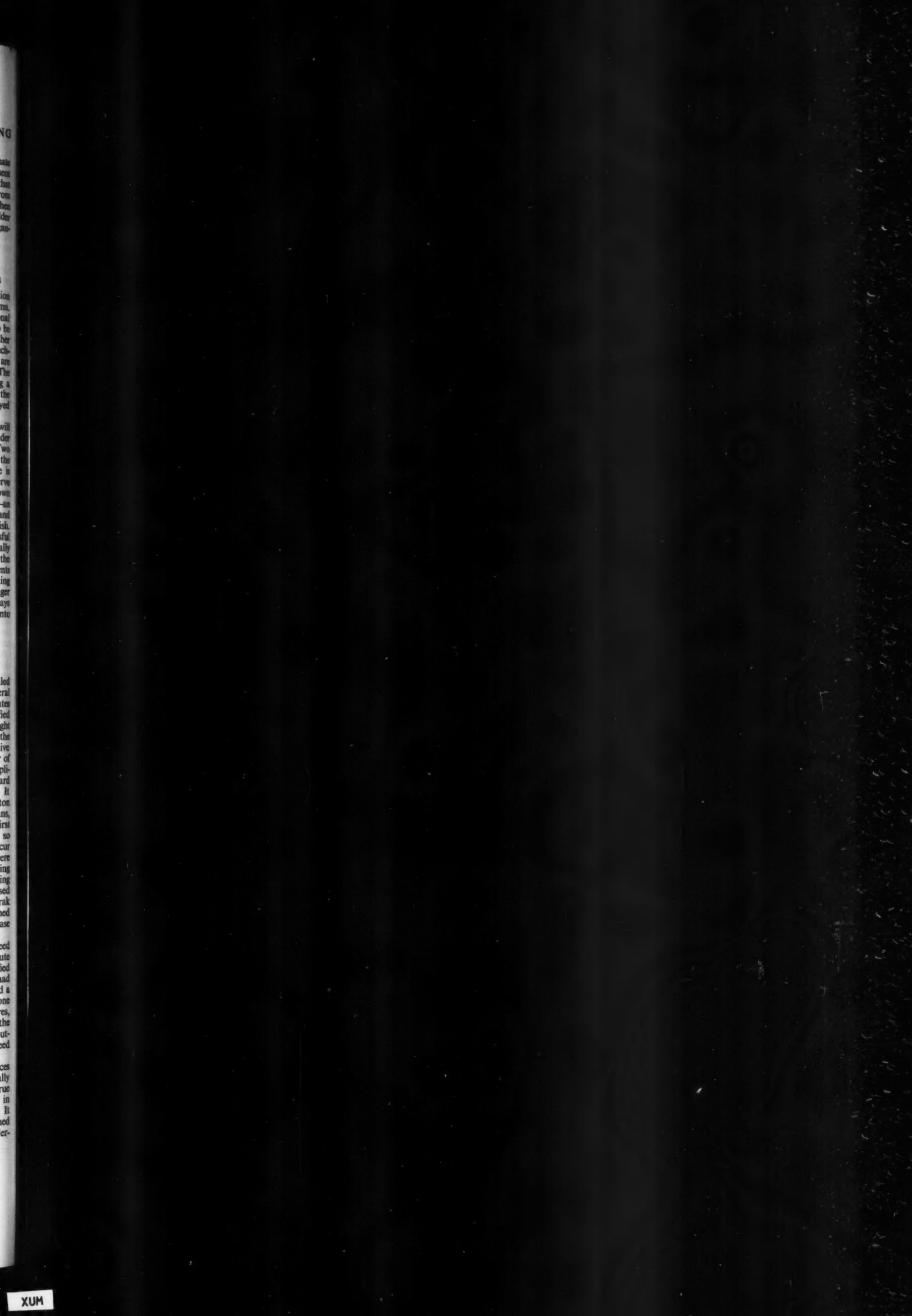
Failure of New Keyboard

For once in the United States the new has failed to dislodge the old. Last year the General Services Administration of the United States Government decided to test a new simplified typewriter keyboard in the hope that it might increase the output of the 164,000 typists on the Federal pay-roll. After four months of intensive trials—conducted by Dr. Earl Strong, director of research at Pennsylvania University—the simplified keyboard failed to dislodge the standard keyboard which was designed in the 1880's. It was in fact in 1873 that the firm of Remington and Sons signed a contract with two Americans, Scholes and Gliddon, to manufacture the first really practical typewriter. The keys were so arranged that the letters which most often occur together, such as T and H, S and T, O and N, were placed as far apart as possible to avoid adjoining type bars catching in each other when moving at high speed. The simplified keyboard, devised as long as 20 years ago by Dr. August Dvorak of the Washington University, Seattle, is designed to minimise finger movement in order to increase speed and reduce fatigue.

At the beginning of the tests the average speed of each team of 10 was 71·8 words for one minute and 54·9 words for five minutes on the simplified keyboard. After four months, these figures had been raised to 95·5 and 66·2 respectively, and a few girls were typing over 100 words in one minute. The standard keyboard team's figures, on the other hand, were 83·5 and 61·7 at the outset, and 113 and 81·7 at the end. The outstanding typist in this group had raised her speed from 122 to 166 words in the minute.

It remains to be seen how the performances were affected by all the typists having originally been trained on a standard keyboard. A true test could only be made with teams trained in the respective keyboards from the outset. It seems inconceivable that something designed 80 years ago should not be capable of considerable improvement.

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